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American Association of Petroleum Geologists, Bulletin. Tulsa, Oklahoma.
American Journal of Science. New Haven, Connecticut.
American Journal of Science Radiocarbon Supplement. New Haven, Connecticut.
American Museum of Natural History, Bulletin. New York.
Arizona Bureau of Mines, [Map]. Tucson, Arizona.
Bulletins of American Paleontology (Paleontological Research Institution). Ithaca, New York.
Cahiers de Géographie de Québec (Université Laval, Institut de Géographie). Quebec.
California, Division of Mines, Bulletin; Mineral Information Service; Special Report. San Francisco.
California, University, Publications in Geological Sciences. Berkeley and Los Angeles.
Canada, Dominion Observatory, Contribution. Ottawa.
Canadian Journal of Physics (National Research Council of Canada). Ottawa.
Columbia University, Lamont Geological Observatory, Contribution. Palisades, New York.
Economic Geology (Society of Economic Geologists). Lancaster, Pennsylvania.
Geochemistry [Geokhimiya]; a translation of the journal of the Academy of Sciences, U. S. S. R., devoted to geochemistry (Geochemical Society). Ann Arbor, Michigan.
Geological Society of America, Bulletin. New York.
Gulf Coast Association of Geological Societies, Transactions. Houston, Texas.
Illinois, State Geological Survey, Circular. Urbana, Illinois.
International Geology Review (American Geological Institute). Washington, D. C.
Journal of Geophysical Research. Washington, D. C.
Kansas, State Geological Survey, Bulletin. Lawrence, Kansas.
Manitoba, Dept. of Mines and Natural Resources, Mines Branch, Publication. Winnipeg, Manitoba.
Military Engineer (Society of American Military Engineers). Washington, D. C.
Mining Engineering (American Institute of Mining, Metallurgical and Petroleum Engineers). New York.
Montana Bureau of Mines and Geology, Memoir. Butte, Montana.
National Academy of Sciences-National Research Council, Publication. Washington, D. C.
New Mexico, Bureau of Mines and Mineral Resources, Bulletin. Socorro, New Mexico.
Pennsylvania Academy of Science, Proceedings. Pittsburgh, Pennsylvania.
Pennsylvania Geological Survey, Atlas; Bulletin; News Letter. Harrisburg, Pennsylvania.
Saskatchewan, Dept. of Mineral Resources, Report. Regina, Saskatchewan.
Science. Washington, D. C.
Shale Shaker (Oklahoma City Geological Society). Oklahoma City, Oklahoma.
State Geologists Journal (Association of American State Geologists). Rolla, Missouri.
U. S. Geological Survey, Geologic Quadrangle Map; Mineral Investigations Map; Miscellaneous Investigations Map; Oil and Gas Investigations Map. Washington, D. C.

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GeoScience Abstracts

1. GEOLOGIC MAPS, AREAL AND REGIONAL GEOLOGY

PART 1. GEOLOGIC MAPS

1-1603. Stipp, Thomas F., and H. M. Beikman. MAP OF ARIZONA SHOWING OIL, GAS, AND EXPLORATORY WELLS, PIPELINES, AND AREAS OF IGNEOUS AND METAMORPHIC ROCKS: U. S. Geol. Survey, Oil & Gas Inv. Map OM-201, scale 1:500,000, 1959.

Oil and gas development in Arizona and locations of more than 200 unsuccessful exploratory test wells drilled, as of May 1, 1958, are shown. Although most of the wells were drilled for oil and gas, some were drilled for water. Outcrops of igneous and metamorphic rocks, major structural features, oil and gas pipelines are shown, and a brief text is included. Stratigraphic sections show rock units, and tables list surface formations and deepest formations penetrated. --U. S. Geol. Survey.

1-1604. Wilson, Eldred D., and Richard T. Moore. GEOLOGIC MAP OF PINAL COUNTY, ARIZONA: Arizona Bur. Mines, Univ. Arizona, scale 1:375,000, 1959.

1-1605. Ross, Clyde P., and J. Donald Forrester. GEOLOGIC MAP OF THE STATE OF IDAHO: U. S. Geol. Survey, scale 1 in. to approx. 8 mi., 1947, reprinted 1959.

1-1606. Schmidt, R. G. BEDROCK GEOLOGY OF THE NORTHERN AND EASTERN PARTS OF THE NORTH RANGE, CUYUNA DISTRICT, MINNESOTA: U. S. Geol. Survey, Mineral Inv. Map MF-182, 5 sheets, scale 1:7,200, 1959.

Mines that have produced Fe ore and manganiferous Fe ore are shown on 5 detailed geologic maps. This publication is the third of 3 that include a total of 10 detailed maps of the North Range. Precambrian argillite, slate, iron-formation, and volcanic rock underlie the area; they have been weakly metamorphosed and tightly folded. A brief text is included. --U. S. Geol. Survey.

1-1607. Nelson, Willis H., and J. P. Dobell. GEOLOGIC MAP AND CROSS SECTIONS OF THE BONNER QUADRANGLE, MONTANA: U. S. Geol. Survey, Misc. Inv. Map I-296, 2 sheets, scale 1:62,500, lat. 46°45'-47°N., long. 113°45'-114°W., 1959.

1-1608. Gray, Carlyle, Alan R. Geyer, and Dean B. McLaughlin. GEOLOGIC MAP OF THE RICHLAND QUADRANGLE, PENNSYLVANIA: Pennsylvania Geol. Survey, Atlas 167 D, scale 1:24,000, columnar sec., cross secs., text on reverse of map, 1958.

1-1609. Moore, George E., Jr. SAROLINA AND QUONOCHONTAUG, RHODE ISLAND. BEDROCK GEOLOGY: U. S. Geol. Survey, Geol. Quad. Map GQ-117, scale 1:31,680, contour interval 10 ft., lat. 41°22'30"-41°30'N., long. 71°37'30"-71°45'W., 1959.

The area is underlain by Precambrian gneiss of sedimentary origin, Devonian(?) or older gneiss of igneous origin, and Pennsylvanian or younger unmetamorphosed granite. Structures in the northern part of the area describe a broad arc convex toward the N.; the dip of these structures and the plunge of lineation are northerly. Foliation in much of the southwestern parts of the area strikes E. and dips steeply N. There is evidence of 2, and possibly 3, episodes of metamorphism. --U. S. Geol. Survey.

1-1610. Power, Walter R., Jr. SLOCUM, RHODE ISLAND. BEDROCK GEOLOGY: U. S. Geol. Survey, Geol. Quad. Map GQ-114, scale 1:31,680, contour interval 10 ft., lat. 41°30'-41°37'30"N., long. 71°30'-71°37'30"W., 1959.

Ten formations are mapped in the Slocum quadrangle. The youngest are metasedimentary rocks of Pennsylvanian age that underlie the eastern margin. The older formations are igneous granite gneiss. They are tentatively correlated with other rocks in Rhode Island whose ages are known from radioactive dating and geologic relations outside the Slocum quadrangle. --U. S. Geol. Survey.

1-1611. Lewis, R. Q., Sr., and R. H. Campbell. PRELIMINARY GEOLOGIC MAP OF THE ELK RIDGE 1 SW QUADRANGLE, SAN JUAN COUNTY, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-200, scale 1:24,000, contour interval 40 ft., lat. 37°45'-37°52'30"N., long. 109°37'30"-109°45'W., 1959.

1-1612. Lewis, R. Q., Sr., and R. H. Campbell. PRELIMINARY GEOLOGIC MAP OF THE ELK RIDGE 4 NW QUADRANGLE, SAN JUAN COUNTY, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-199, scale 1:24,000, contour interval 40 ft., lat. 37°37'30"-37°45'N., long. 109°37'30"-109°45'W., 1959.

1-1613. Lewis, R. Q., Sr., and R. H. Campbell. PRELIMINARY GEOLOGIC MAP OF THE ELK RIDGE 4 SW QUADRANGLE, SAN JUAN COUNTY, UTAH: U. S. Geol. Survey, Mineral Inv. Map MF-198, scale 1:24,000, contour interval 40 ft., lat. 37°30'-37°37'30"N., long. 109°37'30"-109°45'W., 1959.

1-1614. Bramkamp, R. A., and Leon F. Ramirez. GEOLOGY OF THE NORTHWESTERN RUB' AL KHALI QUADRANGLE, KINGDOM OF SAUDI ARABIA: U. S. Geol. Survey, Misc. Inv. Map I-213 A, scale 1:500,000, lat. 20°-24°N., long. 48°-51°E., 1959.

1-1615. Brown, Glen F., and Roy O. Jackson. GEOLOGY OF THE ASIR QUADRANGLE, KINGDOM OF SAUDI ARABIA: U. S. Geol. Survey, Misc. Inv. Map I-217 A, scale 1:500,000, lat. 16°-20°N., long. 42°-45°E., 1959.

1-1616. Brown, Glen F., Roy O. Jackson, and R. G. Bogue. GEOGRAPHIC MAP OF THE NORTHWESTERN HIJAZ QUADRANGLE, KINGDOM OF SAUDI ARABIA: U. S. Geol. Survey, Misc. Inv. Map I-204 B, scale 1:500,000, lat. 24°-28°N., long. 35°-39°E., 1959.

PART 2. AREAL AND REGIONAL GEOLOGY

See also: Stratigraphy 1-1669; Geophysics 1-1709; Sedimentary Petrology 1-1769; Mineral Deposits 1-1808.

1-1617. Jenkins, Olaf P., and others. GEOLOGIC GUIDEBOOK OF THE SAN FRANCISCO BAY COUNT-

IES: California, Div. Mines, Bull. 154, 379 p., illus., maps, cross secs., diags., 1951, approx. 200 refs.; reprinted 1959.

This collection of 32 papers, written by authorities in their respective fields, is organized under 7 headings: historical background, history of the landscape, geologic history, prehistoric life, mineral industry, water, and places to go and routes to travel. The 9 counties adjacent to the bay or to the navigable parts of the Central Valley river system, embrace about 10,500 sq. mi. of valley, hill, and mountain and tide lands where rock accumulation, crustal evolution, and landscape evolution have been extremely complex. These topics are covered in detail. So also is the subject of prehistoric life-vertebrate, invertebrate, and paleobotanical. Because influx of population since the gold rush days of 1848-49 has been phenomenal, expansion of California's mineral industries has also been immense. An abundance of many of the more important raw materials has greatly affected this growth, and resumés of 14 of the more critical groups of minerals are discussed together with brief summaries of relationships between mineral availability and markets. As the expanding population has become increasingly eager for a better understanding of geologic features and processes portrayed in roadside vistas, 82 illustrated pages are devoted to road guide and travelogue material. Virtually every major route is covered. A glossary is added to aid in a better lay understanding of technical geological terminology, some use of which cannot be avoided. --O. E. Bowen, Jr.

1-1618. Johnson, Ollie H., Jr. THE MONROE UPLIFT: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 24-32, 10 figs., 10 pls., 1958.

The Monroe uplift is a complexly truncated dome centering in northeastern Louisiana and extending into adjoining parts of Arkansas and Mississippi. If defined on the truncated limits of the Annona chalk, of Gulf Cretaceous age, it is about 80 mi. in diameter. However, the maximum area of uplift is much greater.

Four electric well log cross sections demonstrate 4 times of great uplift and erosion: beneath the upper Jurassic Smackover formation, between the Cretaceous Comanche and Gulf series, beneath the uppermost Cretaceous Monroe Gas Rock, and between the Eocene Wilcox and Claiborne formations. A total of at least 7,000 ft. of section is missing at these unconformities. Lesser unconformities are also present.

Igenous rocks encountered in wells are interpreted as dikes, sills, and volcanic necks. They demonstrate igneous activity during Gulf Cretaceous and in pre-Jurassic time. --D. C. Van Siclen.

1-1619. Vidrine, Louis O. REGIONAL STUDY OF PORTIONS OF JEFFERSON, PLAQUEMINES AND ST. CHARLES PARISHES, LOUISIANA: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 105-115, 8 figs., 1958, 3 refs.

Electrical well logs and paleontological determinerations were used to study an area of approximately 200 sq. mi. in Jefferson, Plaquemines, and St. Charles parishes, Louisiana. Regional S. dip is interrupted by several salt domes, some of which are complexly faulted. Interesting and somewhat unusual petroleum traps are formed by both N.-dipping and S.-dipping regional faults which strike across a prominent southwestward-plunging structural nose.

Recent to middle Miocene sediments deposited in continental, neritic, and bathyal environments are penetrated by the drill. The environments were fairly uniform over the entire area during deposition of the middle Miocene Bigenerina humblei - Uvigerina lirettensis interval and younger sediments. However, in the central portion of the area a marked facies change occurs in the underlying Cristellaria I zone and older sediments. There a shale which tops the Cristellaria I zone thickens southeastward from its "normal" thickness of less than 200 ft. to more than 1,200 ft., both by shaling out of sands and an undetermined amount of thickening of the shale unit itself. Both electrical log and paleontological correlations between the area of this facies change and the "normal" area are highly questionable. --Auth.

1-1620. Miller, Richard N. GEOLOGY OF THE SOUTH MOCCASIN MOUNTAINS, FERGUS COUNTY, MONTANA: Montana Bur. Mines & Geology, Mem. 37, 44 p., 21 illus., 7 figs., 5 pl., geol. map scale 1:31,680, 3 tables, May 1959, 16 refs.

The South Moccasin Mountains are one of the larger satellitic uplifts within the Judith Mountain group. They rise 5,800 ft. above sea level and 2,200 ft. above the surrounding plains. They are structurally and stratigraphically complete within themselves. Structures including segments of exposed laccoliths, domal uplifts perhaps containing laccolithic cores at depth, and differentially uplifted fault blocks are found within the mountains.

Sedimentary rocks ranging in age from Middle Cambrian to Paleocene have been uplifted in 2 stages of igneous intrusion. Pre-Mississippian faults allowed the earlier porphyritic syenite to move upward easily through older rocks, uplift beginning when the magma spread laterally and concordantly beneath the Mississippian limestone. The Madison and younger formations accommodated the magmas by uplift accompanied by radial faulting. Later porphyritic leucorhyolite utilized these faults to pass beyond to come in contact with strata of late Mississippian, Jurassic, and Cretaceous age. Metamorphism by contact action has not been strong, though hydrothermal alteration has occurred locally.

Known metalliferous deposits contain small amounts of Au, Ag, Pb, and minor Zn and Cu. Fluorspar is found as a gangue mineral. Hydrothermal alteration has produced a deposit of very pure dickite, a form of kaolin, that has commercial possibilities. Gypsum occurs in the lower part of the Piper formation (Jurassic), which encircles the flanks of Hanover dome. It is being mined by the Ideal Cement Company. Mission Canyon limestone (Mississippian) was formerly quarried for the manufacture of Portland cement.

Artesian water has been found within the Kibbey formation (Mississippian). --From auth. abs.

1-1621. Hewitt, Charles H. GEOLOGY AND MINERAL DEPOSITS OF THE NORTHERN BIG BURRO MOUNTAINS-REDROCK AREA, GRANT COUNTY, NEW MEXICO: New Mexico, Bur. Mines & Mineral Resources, Bull. 60, 151 p., 3 figs., 13 pls. (2 in pocket), 10 tables, 1959, 85 refs.

The northern Big Burro Mountains-Redrock area, part of the Basin and Range province, is in Grant County, southwestern New Mexico. Precambrian metamorphic and igneous rocks underlie the NW.--trending mountains; Pliocene(?) Gila conglomerate

and younger, unconsolidated gravels underlie the desert basin SW. of the mountains. N.-dipping, Upper Cretaceous Beartooth quartzite and Colorado shale beds and early to middle Tertiary quartz latite-rhyolite flows cover the northern end of the mountains. Laramide and post-Laramide stocks and dikes have been intruded into Precambrian, Cretaceous, and early Tertiary rocks.

The Precambrian metamorphic rocks include an older Bullard Peak series and a younger Ash Creek series, both of which occur as xenoliths and roof pendants in the Burro Mountains batholith. The Bullard Peak series is made up of interlayered quartz-feldspar gneiss, biotite gneiss, mica schists, hornblende gneiss, and amphibolite. The Ash Creek series is made up of sericite phyllite; andalusite-sericite schist; cordierite, andalusite, and biotite hornfelses; diopside quartzite; and several varieties of serpentine-carbonate rocks. Intrusion of the Burro Mountains batholith resulted in the development of metasomatic muscovite, microcline, and sillimanite and, by lit-par-lit injection, converted part of the Bullard Peak hornblende gneiss and biotite schist to migmatite.

NW.- and NE.-striking normal faults of post-Upper Cretaceous age, which are partly controlled by Precambrian structures, are the dominant structural features.

Precambrian metamorphic deposits of serpentinite, asbestos, and magnetite in the Ash Creek rocks are of mineralogical significance only. Laramide and post-Laramide hydrothermal veins related to stocks and dikes of intermediate composition contain fluorite and manganese oxides, as well as minerals containing W, Cu, Pb, Zn, Ag, and U. --From auth. abs.

1-1622. Fields, Robert W. GEOLOGY OF THE LA VENTA BADLANDS, COLUMBIA, SOUTH AMERICA: California, Univ., Pubs. Geol. Sci., v. 32, no. 6, p. 405-444, 11 illus. on 4 pls., 2 maps, (1 fold.), cross sec., fold, secs. 4 tables, 1959, 17 refs.

Sedimentary rocks in the La Venta badlands [upper Magdalena River basin] range in age from Jura-Triassic to Quaternary. The La Venta beds are apparently of Hettner's Honda formation, here called Honda group, and are dated as late Miocene on the basis of fossil mammals. The deposits vary in lithology, and alternating periods of flooding and drying caused formation of red beds and "torpedo-shaped" concretions. The sediments were derived from nearby sources to the S. and W. They have been slightly faulted and gently folded by contemporaneous and postdepositional tectonic activity. --Auth.

2. GEOMORPHOLOGY

See also: Stratigraphy 1-1672; Geochemistry 1-1743; Sedimentary Petrology 1-1764, 1-1768, 1-1771; Engineering Geology 1-1860.

1-1623. Tanner, William F. EXAMPLES OF DEPARTURE FROM THE GAUSSIAN IN GEOMORPHIC ANALYSIS: Am. Jour. Sci., v. 257, no. 6, p. 458-60, 3 figs., June 1959, 4 refs.

Many cumulative frequency plots of geomorphic data are Type I or Type IV curves in the Pearson system. These depart markedly from the Gaussian distribution. The departures can be investigated quickly by plotting the median elevation (in percent) against a percentile or decile skewness measure. A more precise plot can be obtained from skewness and kurtosis measures based on moments. --Auth.

1-1624. Ives, J. D. GLACIAL DRAINAGE CHANNELS AS INDICATORS OF LATE-GLACIAL CONDITIONS IN LABRADOR-UNGAVA: A DISCUSSION: Cahiers de Géographie de Québec, v. 3, no. 5, p. 57-72, 4 illus., 3 maps, Oct. 1958-March 1959, 17 refs.

This initial report results from author's study of deglaciation in the NE. quadrant of Labrador-Ungava, 1955-1958. Glacial drainage channels are frequently formed during the final stages of glacial wastage. Study of the disposition and form of these channels - lateral, sublateral, or subglacial - may yield information on conditions during the final melting of the ice sheet. The majority of channels in the vicinity of Schefferville (Knob Lake; 54°48'N. 66°48'W.) were formed in sublateral or subglacial positions. N. and W. of a line drawn through the S. end of Kivivic Lake all channels have a predominantly northerly direction of slope; S. and E. of this line, the slope is southerly. This line is referred to as the "theoretical ice divide." The regional direction of slope of the glacial drainage channels across Labrador-Ungava suggests that the regional slope of the ice sheet was comparable in direction with that of the channels and that the progressive downmelting and recession of the ice front proceeded inwards from the E. coast to the W., and ultimately towards the final center of wastage about 25 mi. N. of Schefferville. Study of former ice-dammed lakes strengthens this conclusion. In the Schefferville region the ice, at least during the final stages of wastage, was at the pressure-melting point, the snowline was well above the land surface, large volumes of meltwater formed annually, and the ice was stagnant and melted as detached pieces in situ. The mean annual temperature (and particularly the summer temperature) during the period of final melting of the ice sheet on the "lake plateau" was comparable with, or higher than, that of today. Some comparisons are made with conclusions of a botanist and pollen analyst in this region. --A. C. Sangree.

1-1625. Christiansen, E. A. GLACIAL GEOLOGY OF THE SWIFT CURRENT AREA, SASKATCHEWAN: Saskatchewan, Dept. Mineral Resources, Rept. no. 32, 62 p., 31 figs. incl. maps, (1 in pocket), May 1959, 25 refs.

Three Wisconsin till sheets, and the end moraines of 2, occur within the Swift Current area. These till sheets are separated by outwash and lacustrine sediments deposited during fluctuations of the ice sheets. The lack of weathering, except for oxidation, indicates that the 3 till sheets represent local fluctuations of the glacier during the major retreat. The general direction of ice movement was from the NE., although locally the direction varied considerably.

A loess blanket was derived from the outwash plain W. of the city of Swift Current. The clay minerals of the loess, like those of the tills and lacustrine clays, are essentially montmorillonite

and minor amounts of illite and kaolinite.

Slumping occurs in valleys where streams have cut through the drift into the Bearpaw formation. When streams cut below this contact, the confining pressure is reduced sufficiently to cause the plastic shales to move laterally into the stream valley. The movement of the shale places the overlying competent drift in a state of tension, and fractures are formed. These fractures greatly reduce the internal shear resistance within the drift, and slope failure occurs. Valley widening by this process occurs very rapidly and is related to drift-shale stratigraphy rather than time.

Nonsorted polygons and circles in soils are recent and not periglacial in origin. They are large-scale shrinkage cracks formed by desiccation. During dry periods shrinkage cracks develop into which material from the A_1 horizon is deposited. The cracks and associated infillings cause soil development to take place laterally, and as a result, vertically-plated, solonetzic A'_2 horizons form adjacent to them. As the process continues, more and more of the parent B horizon within the polygon is transformed to A'_2 horizon until the nonsorted polygons become nonsorted circles. --Auth.

1-1626. Stone, Ralph W. CAVES RECENTLY DISCOVERED IN PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 162, 1958.

Sixty caves have recently been discovered bringing the number of caves now known in the state to about 320. The most active groups of explorers are the Nittanny Grotto at Pennsylvania State University and the Pittsburgh Grotto. The largest of the new discoveries is a cave at West York with more than 1,600 ft. of passages --Auth.

1-1627. Ives, Ronald L. SHELL DUNES OF THE SONORAN SHORE: Am. Jour. Sci., v. 257, no. 6, p. 449-57, 4 illus. on 2 pls., 3 figs. incl. 2 maps, June 1959, 16 refs.

The Great Sand Dunes along the NE. shore of the Gulf of California extend from N. of Yuma, Arizona, to S. of Puerto Peñasco, Sonora, but their composition changes abruptly just W. of the Pinacate Peaks, of Sonora. To the N., the dunes are composed largely of rock fragments and are in part reworked Colorado River sediments; to the S. they are composed largely of shell fragments, derived from recently elevated bottom marls, geologically, and probably archeologically, recent. --Auth.

1-1628. Shepard, Francis P. THE EARTH BENEATH THE SEA: 275 p., 113 figs. incl. illus., maps, profiles, diags., Baltimore, The Johns Hopkins Press, 1959, refs.

This volume, prepared for the general reader, is less technical and more up-to-date than the author's Submarine Geology. It deals in turn with waves and currents and their modification of the sea floor; catastrophic waves; beaches; continental shelves and their origin; the continental slope, submarine canyons; the deep-ocean floor; the earth's crust beneath the ocean; coral reefs; the use of present sea-floor deposits to interpret the past. --A. C. Sangree.

1-1629. Bricker, Owen, John H. Moss. ORIGIN OF THE MARSH, EAST NANTMEAL TOWNSHIP, CHESTER COUNTY, PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 168-71, 3 figs., 1958.

The large upland swamp called The Marsh recently aroused interest when the pollen spectrum of samples taken at shallow depths indicated a tundra flora of Pleistocene age. The Marsh lies in the Piedmont physiographic province about 50 mi. S. of the Wisconsin glacial border and must have been a periglacial swamp during the advance of the ice to the Wisconsin terminal moraine. The discovery of the cold-climate pollen raised a question concerning the geologic conditions governing the origin of such a large swamp in the Piedmont. It is the authors' belief that differential erosion due to differences in rock composition and structure have been the major factors governing the formation of The Marsh. --Auth.

1-1630. Price, W. Armstrong. SEDIMENTOLOGY AND QUATERNARY GEOMORPHOLOGY OF SOUTH TEXAS: SUPPLEMENTARY TO FIELD TRIP MANUAL "SEDIMENTOLOGY OF SOUTH TEXAS." CORPUS CHRISTI GEOLOGICAL SOCIETY SPRING FIELD TRIP: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 41-75, 22 figs., 4 pls., 3 tables, 1958, 71 refs.

Based on 40 years of field work this paper briefly describes and interprets numerous southwestern features. New terms introduced are: aligned lakes, banner dune complex, banner train; also captive islands, flying spit islands, stepped-back eolian ridged plains, washarounds and washovers of the contemporary barrier and lagoon. These and associated features are described.

An amended list of the vertebrate and molluscan fauna of the Pleistocene Ingleside (Eunice) barrier includes turkey gastroliths. A long erosional scarp of a transgressive pre-Ingleside sea and various barrier and lagoon features are described.

The Rio-Grande-Pecos stream system, as interpreted, grew by headward capture (Gulf to Rockies) of flank drainage of a rain-condenser mountain range, with the parent stream the shortest and steepest. The Brazos and Colorado are beheaded remnants.

A Pleistocene longitudinal dune-field pattern crossing Llano Estacado is outlined by dune swales etched in caprock, captured drainage and alignments of oriented swale lakes. The lakes are largest at Amarillo, forming dry-region counterparts of Carolina "bays." Caprock origin is discussed.

The S. Texas sand plain is the rejuvenated northern part of a Pleistocene Rio Grande delta erg, outlined by stabilized longitudinal dunes and an unknown type now conical. The sand source is discussed.

Pleistocene (glacial period?) dune-making United States wind resultants, some 90° to the modern counterparts, form a wheelround pattern of continent-wide concentric circles (Arizona to Idaho, Montana, Maryland, and Texas) like those described by L. Aufrere and C. T. Madigan for the present N. African and Australian deserts. The wind systems are unexplained. --Auth.

3. STRUCTURAL GEOLOGY

See also: Areal and Regional Geology 1-1618; Stratigraphy 1-1644, 1-1653, 1-1667; Geophysics 1-1699, 1-1716; Sedimentary Petrology 1-1766; Fuels 1-1837.

1-1631. Gzovsky, M. V. THE USE OF SCALE MODELS IN TECTONOPHYSICS. Translated by L. Drashevska: Internat. Geology Rev., v. 1, no. 4, p. 31-47, 11 figs., table, Apr. 1959, 59 refs.

The author, using the theory of physical similarity as developed in the U. S. S. R. and equations describing the development of folds and faults in rocks, theoretically proves the possibility of using scale models in tectonophysics.

New instruments necessary for investigation of equivalent materials (which are necessary for conditions of similarity) have been created in the U. S. S. R. Some substances having properties meeting model-material requirements have been known for a long time. New materials with the required properties have also been created. As a result, scale models can be practically used to study tectonic deformation and fractures.

The fundamental principles of the optical method of investigation of stress state of elastic and plastic transparent models are described, indicating that the scale-model method may be used for the investigation of the tectonic-stress fields in the earth's crust.

Three examples demonstrate the ability of the scale-model method to help solve different geological and geophysical problems. The hypothetical physical conditions of 2 types of folds - longitudinal bending and longitudinal thickening - were checked.

The notions about the distribution of tectonic faults formed during the growth of transversal bending anticlines were made more precise with the aid of transparent models.

Transparent plastic models are used to study the ratio of the magnitude of tangential stresses in the region of earthquake foci to the velocity of the movement of the earth's crust. In elastic transparent models it is possible to see changes in the character of earthquake foci with time due to the development of tectonic faults. In such models, the influence of a type of tectonic deformation and fault magnitude on the value of seismic energy generating from the earthquake focus can be studied. All these data cannot be obtained by only field investigations. Therefore, even experimental information obtained from scale models facilitates the development of geological criteria of seismicity.--Ed. abs.

1-1632. Hill, Mason L. DUAL CLASSIFICATION OF FAULTS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 1, p. 217-21, diag., table, Jan. 1959, ref.

A nomenclature of faults is needed which will indicate whether the determined relative movement is actual or apparent. In this dual classification system, to include "slip" in the name implies that actual relative movement is known; to leave out the word "slip" implies that only apparent relative movement is known. --M. Russell.

1-1633. Watson, Edward H. TRIASSIC FAULTING NEAR GWYNEDD, PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 122-27, 3 figs., pl., 1958, ref.

About 1 mi. SE. of North Wales, Montgomery County, Pennsylvania, the Reading railroad goes through a cut over 3,000 ft. in length and much of it 100 ft. deep. Within the cut about 60 normal faults are exposed and for 56 of these the stratigraphic throw can be determined by the displacement of recognizable units. The throw for 56 of the faults averages 5 ft. The range in stratigraphic throw is from an inch or so to a maximum of 62 ft. Only 4 faults, however, are greater than 10 ft. Assuming the average for the 4 indeterminate faults, the total cumulative stratigraphic throw through the cut is 305 ft.

The true thickness of the rocks exposed will be the apparent thickness calculated to be 1,163 ft. minus 305 ft., which is the summation of the stratigraphic throws, equaling 858 ft., the true thickness. The increase of thickness due to faulting is therefore 33.5%

The casual observer may think small throws of this nature inconsequential, but as this analysis shows, if they are distributed over wide areas they become appreciable. --Pennsylvania Geol. Survey.

1-1634. Mendelsohn, F. EN ECHELON FOLDING: Econ. Geology, v. 54, no. 3, p. 505-509, diag., 1959, 3 refs.

Discussion of paper by J. D. Campbell (Econ. Geology, v. 53, no. 4). An anticlinal echelon fold comprises 2 anticlines and a shared syncline arranged en echelon. A synclinal echelon fold comprises 2 synclines and a shared anticline arranged en echelon. A pod fold is one occurring on and confined to the flank of a syncline or anticline. Echelon and pod folds are the basic fold forms. Both echelon and pod folds occur in the Roan Antelope deposit, Northern Rhodesia, Africa. The Birthday anticline, Birthday Gift mine, Burbanks, consists of 2 linked anticlinal echelon folds. Exception to certain of J. D. Campbell's statements and conclusions is taken and examples given to illustrate why. --M. Russell.

1-1635. Wise, Donald U. AN EXAMPLE OF RECUMBENT FOLDING SOUTH OF THE GREAT VALLEY OF PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 172-76, fig., 1958, 3 refs.

In the Beekmantown limestone [Lower Ordovician], at Rheems, Lancaster County, Pennsylvania, quarry operations have revealed an example of a style of folding common in the Great Valley to the N. Flow folds, indicative of considerable tectonic transport, show closely spaced axial planes traceable for 700 ft. across the strike with an average dip of only 3°. The pattern of these folds is presented and some of the differential pressure effects during flow are discussed. --Auth.

1-1636. Christie, John M., and C. B. Raleigh. THE ORIGIN OF DEFORMATION LAMELLAE IN QUARTZ: Am. Jour. Sci., v. 257, no. 6, p. 385-407, 8 figs., June 1959, 21 refs.

Fabrics of 4 quartzite specimens containing numerous quartz grains with deformation lamellae are described in detail. Patterns of preferred orientation of deformation lamellae in all 4 specimens are similar in that the poles of the lamellae define a small-circle girdle (about an axis designated A). The orientations and strengths of maxima within the girdle, however, are not consistent in different specimens. [0001]-axes of grains containing deformation lamellae also define a small-circle girdle about the same axis (A). In each specimen the great-circles containing [0001] and the pole of the deformation

lamellae for individual grains pass through, or close to, the axis A of the small-circle girdles.

The deformation lamellae are shown to be late structures unrelated to the deformations which induced the preferred orientation of the quartz grains in the rocks. The lamellae are not parallel to rational crystallographic planes and they are considered to represent kink-bands resulting from shearing parallel to [0001] on irregular planes in the zone of [0001]. The shearing is probably controlled by imperfections in the crystal structure, which commonly exist parallel to [0001] in quartz.

According to this hypothesis the axis (A) of the small-circle girdle defined by poles of lamellae is the axis of maximum compressive stress during the deformation which produced the lamellae. This relationship may be used to obtain a dynamic interpretation of deformation lamellae in quartzose sedimentary and metamorphic rocks. The hypothesis is tested using data from the Baraboo quartzite and it is demonstrated that the deformation lamellae in the rocks of this formation may be related to the folding of the Baraboo syncline. --Auth.

1-1637. Burtner, Roger, Richard Weaver, and Donald U. Wise. STRUCTURE AND STRATIGRAPHY OF KITTATINNY RIDGE AT SCHUYLKILL GAP, PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 141-45, fig., 1958, 2 refs.

Detailed stratigraphic measurement and structural mapping of a new roadcut through Kittatinny Ridge at Schuylkill Gap indicates that a major fault repeats approximately 500 ft. of Clinton quartzites [Silurian] of 2 slightly different facies. Other structural features present in the order in which they formed are: excessive bedding plane slippage and faulting, horizontal fold axes, and normal faults. --Auth.

1-1638. Flawn, Peter T., and Teodoro Díaz. PROBLEMS OF PALEOZOIC TECTONICS IN NORTH-CENTRAL AND NORTHEASTERN MEXICO: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 1, p. 224-30, map, table, Jan. 1959, 19 refs.

Pre-Mesozoic terrane of northern Mexico consists of a granitic area in eastern Coahuila bordered on the W. by Pennsylvanian(?) and Permian rocks, on the E. by sedimentary rocks of unknown age and on the SE. by Mississippian-Permian rocks in fault contact with pre-Mississippian gneiss and schist. The area was a Paleozoic tectonic land. No direct or simple connection with the Ouachita belt of the United States can be implied, but it may be an extension of an interior zone of the Ouachita system. Alternatively, the Mexican Ouachita may have resulted from a younger foredeep on its foreland side. The Ouachita peninsula is probably a Paleozoic structural unit. Oil and gas, if present, should occur NW. of the Sierra del Cuervo and Placer de Guadalupe exposures, possibly in northeastern Chihuahua. --M. Russell.

1-1639. Godin, Yu. N., N.P. Luppov, Yu. I. Sytin, and P. K. Chikhachev. PRINCIPAL FEATURES OF THE TECTONIC STRUCTURE OF TURKMEN SSE. OM THE PROBLEM OF THE OIL-AND GAS-BEARING CHARACTER OF THE WESTERN REGIONS OF CENTRAL ASIA. Translated by Theodore Shabad: Internat. Geology Rev., v. 1, no. 4, p. 1-17, map, Apr. 1959, 10 refs.

The Turkmen SSR and adjoining areas is potentially a great producer of oil and gas. Four principal stages in the geologic history are: 1) Paleozoic geosynclinal development, 2) Permian-Triassic uplift with local basins of deposition, 3) Extensive subsidence and deposition during Jurassic, Cretaceous, and Paleocene with local faulting and folding, 4) Alpine tectonic movement during Neocene and Quaternary. Three predominating structural types are: 1) the cratonic section consisting of 4 relatively stable rectonic zones or inner blocks, 2) a transitional zone from 30 to 80 km. wide of marginal depressions, and 3) an alpine geosynclinal region consisting of the S. Caspian inner block and the Iranian inner block.--M. Russell

4. STRATIGRAPHY AND HISTORICAL GEOLOGY

See also: Areal and Regional Geology 1-1622; Structural Geology 1-1637; Paleontology 1-1688, 1-1691; Geophysics 1-1723; Sedimentary Petrology 1-1765, 1-1766, 1-1773; Fuels 1-1818, 1-1837, 1-1856, 1-1857.

1-1640. Ilin, A. V. STRATIGRAPHY OF PRE-CAMBRIAN ROCKS OF THE WESTERN SECTION OF THE SANGILEN HIGHLAND (TUVA). Translated by L. Drashevska: Internat. Geology Rev., v. 1, no. 4, p. 18-25, 4 figs. incl. map, 2 secs., diag., Apr. 1959, 4 refs.

The stratigraphic sequence of the Precambrian complex of the western Sangilen Highlands, Tannu Tuva, include schists, schistose sandstones, fine-gravel conglomerates, micaceous and ferruginous quartzites, graphitic marbles, and gneisses of the Teskhem, Mugur, Balyktyghkem, Chartyss, and Naryn formations, which grade upward into one another without break. Deposits containing Lower Cambrian fossils are also known in the area. The ferruginous quartzites, associated with the upper Mugur, mark the principal boundary in Precambrian sedimentary accumulation and indicate the change from terrigenous sediments to calcareous marine sedimentation.

The degree of metamorphism varies considerably, both horizontally and vertically. Terrigenous deposits correspond to the green-schist facies. Local variations in the metamorphism of calcareous deposits apparently result from the variability of original components. Also important is the superimposed injection metamorphism associated with Proterozoic intrusions. --Ed. abs.

1-1641. Willard, Bradford. LOWER ORDOVICIAN, LEHIGH AND DELAWARE VALLEYS: Pennsylvania Acad. Sci., Proc., v. 32, p. 177-82, 1958, 27 refs.

"Beekmantown" has for some years been used to include the Ordovician part of the dolomitic limestones in the Lehigh Valley. The name is not appropriate because of the lack of correlation with the type Beekmantown and because of the presence of post-Beekmantown fossils. Wherry's designation, Coplay formation, is revived and the type locality redefined. --Auth.

1-1642. Prouty, C.E. THE ANNVILLE, MYERSTOWN AND HERSHEY FORMATIONS OF PENNSYLVANIA:

Pennsylvania Geol. Survey, Bull. G 31, 47 p., 19 figs., pl., 9 secs., table, June 1959, 23 refs.

The indefinite status of the "Leesport formation" [Middle Ordovician] of Pennsylvania has prompted its restudy. Inconsistent mapping of the "Leesport" apparently reflects the structural and lithologic complexities of the type section at West Leesport, Pennsylvania, and the inconsistencies preclude satisfactory redefinition of the formation.

The rocks comprising the approximate interval of the "Leesport" as mapped by G. W. Stose are herein assigned new names, from oldest to youngest, the Annville limestone, Myerstown limestone, and Hershey limestone. The high-Ca Annville limestone occurs in a relatively narrow strip from near Wernersville to Harrisburg, where it is believed to rest accordantly on the middle member of the "Stones River" group and to grade westward into the upper calcilutite member of that "group." The age of the essentially unfossiliferous Annville must then depend on the age assignment of the upper "Stones River," but is provisionally considered late Chazy. The Myerstown limestone is darker and has a higher clay content than the Annville, upon which it rests disconformably. It essentially represents the lower Jacksonburg formation of western New Jersey, and the "Cement limestone" of B. L. Miller. The few fossils found would indicate a lower Trenton age. Southwestward from Harrisburg the Myerstown grades into the Mercersburg limestone and lower Salona (Oranda) facies. The Hershey limestone is higher in clay content than the Myerstown and represents essentially the "Cement rock" of eastern Pennsylvania, and the upper Jacksonburg of western New Jersey. The Hershey has approximately the same distribution as the Myerstown limestone, from about the Delaware River on the E. to the Harrisburg area from whence westward it is represented by the upper Salona limestone and lower Martinsburg formation. Lateral relationships indicate a middle Trenton age.

Abrupt facies changes of the Annville-Hershey rocks in the Harrisburg area point to the continued effectiveness of the "Harrisburg axis" as an important paleostructure in post-Chazy to pre-middle Trenton time. Also, the presence in the Reading area of a disconformity beneath the Martinsburg formation, in addition to data on the distribution of the Annville-Hershey rocks, indicate the presence of a paleostructure in the Reading area referred to herein as the "Reading axis."--Auth.

1-1643. Sutton, Robert G. USE OF FLUTE CASTS IN STRATIGRAPHIC CORRELATION: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 1, p. 230-37, 4 figs. incl. illus., map, sec., table, Jan, 1959, 10 refs.

The presence of black shales and orientation of flute casts is the basis of a correlation between Seneca Lake and Cayuga Lake Upper Devonian rocks in New York. The West River shale is equivalent to the Sherburne sandstone and Ithaca formation. The Naples group is approximately equivalent to the Enfield shale. The Grimes sandstone is apparently equivalent to the lower Cayuta formation. --M. Russell.

1-1644. McLaughlin, Dean B. TRIASSIC NORTH BORDER NEAR SOUTH MOUNTAIN: Pennsylvania Acad. Sci., Proc., v. 32, p. 151-55, fig., 1958, 3 refs.

An important fault forms the Triassic border along the foot of South Mountain, but it is discontinuous, and in adjoining localities strata high up in the Triassic column directly overlap the Paleozoics unconformably. Probably the Triassic sediments were deposited in a deep intermontane valley, and the present N. border marks the position of a steep escarpment against which they piled up. The very local derivation of the Triassic sediments is shown by the close association of "shale conglomerate" with outcrop areas of Martinsburg shale, and by the presence of Hardyston cobble conglomerate only near the Hardyston outcrop on South Mountain. Since this conglomerate is limited to the uppermost beds of the Gettysburg, we conclude that the erosion of the Hardyston on South Mountain did not begin until late Gettysburg time.

The most remarkable feature of this area is the nearly complete lack of limestone conglomerate. This seems to require a cutting out of the limestone sequence near South Mountain, either by faulting or by a great unconformity in the Paleozoic. --Auth.

1-1645. Goodman, A.J., ed. JURASSIC AND CARBONIFEROUS OF WESTERN CANADA, WITH RELATED PAPERS; A SYMPOSIUM, MOST PAPERS OF WHICH WERE PRESENTED AT THE WESTERN CANADA REGIONAL MEETING, JASPER, ALBERTA, SEPTEMBER 15 AND 16, 1955; SPONSORED BY THE AMERICAN ASSOCIATION OF PETROLEUM GEOLOGISTS AND THE ALBERTA SOCIETY OF PETROLEUM GEOLOGISTS: 514 p., illus., maps, secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958, refs.

A collection of 24 papers, including an introduction dealing with petroleum and natural gas prospects in the Mississippian and Jurassic of western Canada, 7 papers on the Jurassic followed by a discussion, and 16 papers on the Carboniferous, with discussion. Each of these papers is abstracted separately below in the order in which it appears in the symposium. --A. C. Sangree.

1-1646. Sproule, J.C. PETROLEUM AND NATURAL GAS PROSPECTS OF MISSISSIPPIAN AND JURASSIC OF WESTERN CANADA: (In: Goodman, A.J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 3-9, map, 3 tables, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958)

From the standpoint of future oil and gas reserves the Mississippian has recently become one of the most important rock groups in the western Canadian sedimentary basin. Present indications are that, over the next 20 years, the Mississippian may either rank with or exceed, in its oil discovery record, the Cardium formation and the Devonian system. The Jurassic also is expected to play a more active part as a producer of oil and gas in the future than it has in the past. --Auth. concl.

1-1647. Frebold, Hans. STRATIGRAPHY AND CORRELATION OF THE JURASSIC IN THE CANADIAN ROCKY MOUNTAINS AND ALBERTA FOOTHILLS: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 10-26, 2 illus., map, 2 secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 61 refs.

The Jurassic of the Canadian Rocky Mountains and foothills comprising the Fernie group and the

lower part of the Kootenay and Nikanassin formations is subdivided on a paleontological basis into a number of units which correspond to zones and stages of the NW. European standard section. The following stages are shown to be present by their index fossils - part of the Sinemurian, the Toarcian, the middle Bajocian, the lower Callovian, at least part of the Oxfordian and Kimmeridgian, and the upper Portlandian. A most significant feature of the Fernie group is its incompleteness, only 11 or 12 of the 59 NW. European ammonite zones being proved to be present. Ammonite zones belonging to the Hettangian, parts of the Sinemurian, and the Pliensbachian are definitely absent. Stratal equivalents of the lower and upper Bajocian, Bathonian, upper Callovian and parts of the Oxfordian, Kimmeridgian, and Portlandian are not indicated by index megafossils and may be entirely absent or represented by sediments without megafauna.

A variety of different facies is developed which can only be correlated by index fossils common to different facies districts. Some of the most prominent facies units are the Nordegg member, the Paper or Poker Chip shale of the lower Fernie, the middle Bajocian Rock Creek member, the Callovian Corbula munda beds and Gryphaea bed which are equivalent to the Grey beds, the Oxfordian Green beds, and the Passage beds which are mainly of Kimmeridgian age.

Correlations of the Rocky Mountains and foothills Jurassic with the Jurassic deposits in British Columbia, Yukon, Prince Patrick Island, and Manitoba are established. Absence of index megafossils in the Jurassic of the Alberta, Saskatchewan, and Manitoba plains renders correlation of these areas with the Fernie group difficult. A tentative attempt has been made to correlate these areas on the basis of existing literature and through the co-operative efforts of the Jurassic symposium committee. Interpretation of the data obtained from field studies has made possible a synthesis of the present Canadian Rocky Mountains and foothills region during Jurassic time, a region which is considered as a nongeosynclinal border zone between the Cordilleran geosyncline in the W. and the land Laurentia in the E. --Auth.

1-1648. Klingspor, Arthur M. JURASSIC STRATIGRAPHY OF THE SWEETGRASS ARCH - MANITOBA SECTION: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 27-51, 3 maps, 10 cross secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 20 refs.

In southern Saskatchewan and Manitoba the interval between the late Paleozoic and late Jurassic epeirogenies is represented in stratigraphic order by continental red beds, evaporites, carbonates, and clastics, all of which are assigned to the Jurassic system. The sequence is in excess of 1,400 ft. thick in S.-central Saskatchewan and thins to the N., W., and E. Depositional and erosional thinning are complementary, and the northern limits are determined by late Jurassic to post-Jurassic truncation.

The system was divided into the Watrous, Gravelbourg, Shaunavon, and Vanguard formations, each representing widely recognizable lithologic units.

Proof of Jurassic age is available for the Gravelbourg, the Shaunavon, and Vanguard formations, which appear to represent the Bajocian to Kimmerdgian time interval. The evaporites of the Watrous formation possibly represent the lower Bajocian or earlier Jurassic stages.

A minor unconformity of Middle Jurassic age is indicated by the occurrence of chert on top of the marine carbonates of the Gravelbourg. The evidence for this unconformity is strongest in central and SE. Saskatchewan. There the anhydrite of the Watrous formation thickens markedly, and the evaporitic conditions appear to have lasted longer than in western Saskatchewan. In the same area the marine sediments above the unconformity thin and gradually change facies. The carbonates to the W. are substituted by clastics, and coarse clastics appear in increasing amounts in an easterly direction. It would appear that a separate basinal area existed toward the end of Middle Jurassic time in Manitoba, receiving clastic sediments from the N. and E.

The Shaunavon formation cannot be traced lithologically in this facies district, but approximately equivalent picks can be made from electric and radiation logs. The lithologic character of the uppermost Gravelbourg, Shaunavon, and Vanguard formations in Manitoba resembles closely that of the Sundance formation in North and South Dakota.

Callovian time is represented by the lower part of the Vanguard formation. A slight unconformity is recognizable between the lower and the middle Vanguard at the basin rim in western Saskatchewan. The middle Vanguard is largely marine in the basin center, but around the basin rims, brackish, or locally continental, sediments represent this member. Most of these sediments appear to be of Oxfordian age. The lithologic character of the upper Vanguard together with the fact that it contains reworked fragments of older Jurassic faunas indicates redeposition of material from the truncated basin flanks into the center.

The hiatus between Upper Jurassic and Lower Cretaceous is recognizable only along the basin rims. In the deeper portions of the Jurassic basin a more gradual change from marine to brackish into continental deposition appears to have taken place between Upper Jurassic and Lower Cretaceous time. Truncation in these portions appears to have occurred later, possibly in post-Jurassic time, and, to a lesser degree than on the rims. In the basin center there is no evidence of truncation but merely of a transition from marine into brackish sedimentation. --Auth.

1-1649. Thompson, R. L., and M. B. B. Crockford. THE JURASSIC SUBSURFACE IN SOUTHERN ALBERTA: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 52-64, 5 maps, cross secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 8 refs.

Sediments of Middle Jurassic and Upper Jurassic age are present in the extreme southern plains and in the foothills and mountain areas of Alberta. On the plains the northern boundary of the Jurassic is roughly crescentic in shape, approximately coinciding with the South Saskatchewan River and its tributary, the Oldman river, and from there trending northwestward, passing a few mi. E. of Calgary. On the Alberta plains, Jurassic strata are readily divisible into 3 formations, which were originally described and named in Montana, and which are, in ascending order, Sawtooth, Rierdon, and Swift. In the Alberta foothills, Jurassic strata are called the Fernie group, which is roughly the equivalent of the 3 formations of the plains.

Jurassic strata in southern Alberta rest unconformably on the Rundle formation of Mississippian age. On the plains they are overlain unconformably by the basal sandstones of the Blairmore formation

which have been correlated with the Cutbank and Sunburst sands of Montana. Post-Jurassic erosion truncated the formations so that they wedge out northward; consequently, the Swift being the uppermost has a very limited distribution in Alberta, having been eroded completely from the crest of the Sweetgrass arch and remaining only in the extreme southeastern corner of Alberta and in a narrow belt paralleling the foothills. The Rierdon and Sawtooth formations extend northward approximately to the limits of the Jurassic as defined above. In the western foothills the Fernie is overlain conformably in most places by Kootenay sandstone and shale of Lower Cretaceous age.

The Sawtooth formation consists of 2 sandstone members, separated by green, pyritic, noncalcareous shale. The upper sand or its equivalent is a reservoir for oil and gas in several small fields in Alberta. The formation has a maximum thickness of about 235 ft. The Reirdon formation is made up of alternating gray calcareous shale and greenish-gray limestone with some pyrite, glauconite, and ironstone, and has a maximum thickness of 250 ft. The Swift formation lies unconformably on the Rierdon and has a maximum thickness of 150 ft. It consists of glauconitic sandstone, siltstones, concretions, dark gray shale, and generally has chert pebbles at the base.

Facies change from W. to E. in the Fernie group of the Foothills to the Ellis group of the southern Alberta plains; but the changes are not so pronounced as to preclude the making of satisfactory correlations. On the E. flank of the Sweetgrass arch the Ellis group can be readily correlated with the Gravelbourg, Shaunavon, and Vanguard formations of Saskatchewan. However, they are not the exact equivalents of these formations as some overlapping occurs. -- Auth.

1-1650. Milner, R. L., and G. W. Blakslee. NOTES ON THE JURASSIC OF SOUTHWESTERN SASKATCHEWAN: (In: Goodman, A.J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 65-84, 7 maps, 8 cross secs., Tulsa. Oklahoma, American Association of Petroleum Geologists, 1958) 4 refs.

Four Jurassic formations are recognized in southwestern Saskatchewan - the Watrous, Gravelbourg, Shaunavon, and Vanguard. Since the type sections of these formations were first established, additional drilling has made it advisable to redefine the 3 members of the Vanguard formation.

The 4 formations are described briefly and attempts are made to illustrate the correlation between them and the Sawtooth, Rierdon, and Swift formations of the Ellis group of Montana.

The difficulties experienced in determining the Jurassic-Cretaceous boundary are illustrated by means of several cross sections. --Auth.

1-1651. Lackie, J. H. SUBSURFACE JURASSIC OF THE PEACE RIVER AREA: (In: Goodman, A.J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 85-97, 3 maps, 6 cross secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 12 refs.

Marine Jurassic sedimentary formations of this area [of Alberta] can be correlated tentatively with those lying beneath the southern plains of Alberta and in the foothills to the SW. The Fernie group consists of dark marine shales and sandstones with minor amounts of limestone and chert.

Southeast of Sturgeon Lake limestones and cherts become prominent in the lowest part of the group. The distribution of these beds has been influenced by late Jurassic or early Cretaceous erosion, which truncated the strata to the N. and NE. They lie on an erosional surface which cuts across the top of both Triassic and Paleozoic strata. The equivalents of the Nordegg member, the Poker Chip shale, and the Rock Creek member can be recognized. The constant lithology of the Nordegg member permits well-defined correlations. --Auth.

1-1652. Chamney, T. P. ISOMETRIC PANEL DIAGRAM - JURASSIC SYSTEM: (In: Goodman, A.J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 98-99, table, pl. (fold. in pocket), Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) ref.

Representative surface and subsurface sections were selected from the author's Jurassic study areas and correlated into a regional isometric panel diagram. Lateral correlation from one area to another was accomplished by means of committe study groups to arrive at an agreement between authors. The committee was able to summarize the correlations for the Williston basin and southern Alberta basin.

Correlation from the Williston and southern Alberta basins into the foothills belt and northern Alberta basin requires additional subsurface control. Three major stratigraphic divisions of the Jurassic in this area may be conveniently summarized into corresponding Upper, Middle, and Lower series. The Upper series includes Kootenay-Nikanassin sands and the underlying "Passage beds" and "Green beds" (Swift) of the uppermost Fernie group. Belemnite horizons are common in the latter 2 units.

The top of the Middle series is represented by a significant, highly fossiliferous, impure limestone or hard calcareous shale of the "Grey beds." This is designated as the Gryphaea impressimarginata and Corbula munda beds of Frebold (1957) (Rierdon). The base of the unit in the vicinity of Blairmore, Alberta, contains a bioclastic limestone, the Lille member (Piper), underlying the Rock Creek member.

The Lower series of the Jurassic includes the remaining lowermost Fernie group. The most distinctive lithology is the dark-gray to black phosphatic shale and phosphate nodules, associated in part with chert as in the Nordegg member. The possible equivalent sedimentary interval of this Lower series in the Williston basin province is considered to be the "Red beds" of the Watrous formation. This would be correlative in part with the initial Gypsum Spring deposition.

The most significant regional Jurassic marker horizon, representing a hiatus in many areas, is the top of the Rierdon (A. A. P. G. subcommittee chart). In the Williston basin and adjacent areas it is recognized by a characteristic electric-log marker. The lithologic change is from the calcareous Rierdon shale to an overlying noncalcareous, silty, "mustard" shale with Fe mineralization. A comparable sharp lithologic change is present in the foothills between the impure limestone of the "Gray beds" (Rierdon) and the overlying soft, silty shales of the "Green beds" (Swift).

The most diagnostic feature of this marker is its highly fossiliferous nature. Gryphaea impres-

simarginata and Corbula munda are most common. There is also a distinct microfaunal change from predominantly lagenid Foraminifera of the Rierdon to simple arenaceous Foraminifera of the Swift. --Auth.

1-1653. Peterson, James A. MARINE JURASSIC OF NORTHERN ROCKY MOUNTAINS AND WILLISTON BASIN: (In: Goodman, A.J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 100-141, 13 maps, 5 cross secs., 2 tables, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 46 refs.

Regional studies indicate that the pattern of sedimentation within the Jurassic seas of the northern Rocky Mountains was influenced by several associated paleotectonic elements. The major negative-trending units were the Alberta and Twin Creek troughs and the Williston basin. The major positive-trending elements were the Belt island and the Sheridan arch. Regionally the marine Jurassic can be separated into lithogenetic units whose characteristics appear to be directly related to the presence of sedimentary environments, the nature of which was governed by the position and relative activity of the various paleotectonic elements.

The Piper and Rierdon formations and their equivalents are each separated into 3 regional units of member rank. The lithologic nature of these units is believed to be related in a large way to the position of Belt island and its effect upon the salinities, temperature, and current distribution in the waters of the Twin Creek trough and the Williston basin and the intervening Montana-Wyoming shelf area. Much of the misunderstanding concerning the Jurassic stratigraphy of the Williston basin is believed to be caused by an inadequate knowledge of the regional nature of the Jurassic units. --Auth.

1-1654. Moore, P. Fitzgerald. LATE PALEOZOIC STRATIGRAPHY IN THE ROCKY MOUNTAINS AND FOOTHILLS OF ALBERTA - A CRITICAL HISTORICAL REVIEW: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 145-76, 4 secs., diag., chart, 3 tables, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 43 refs.

The Carboniferous and Permian formation names currently in use in Alberta were first set up at many different localities - superposition cannot be proved in every case. Two synthetic standard sections are presented, and correlations in the Bow Valley and N. to the Peace River country are illustrated by 2 stratigraphic cross sections. On the basis of these correlations the history of nomenclature is critically reviewed. It is shown why the Alberta Society of Petroleum Geologists Committee adopted some names and discarded others. Miscorrelation of Meramecian dark shaly limestones (Mount Head formation) in the Rocky Mountains, with Osagean beds of a similar lithology (Shunda formation) in the foothills has been the main cause of confusion in earlier attempts to subdivide the late Paleozoic of Alberta. --Auth.

Discussion by G. O. Raasch, D. G. Penner, G. H. Austin, and P. Harker, p. 174-76.

1-1655. Douglas, R. J. W., and Peter Harker. MISSISSIPPIAN SUCCESSION IN MOUNT HEAD AREA, ALBERTA: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 177-89, map, 5 tables, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 11 refs.

The Mississippian rocks of Mount Head area in the southern foothills of Alberta are included in the standard formations of the Alberta Rocky Mountains - the Banff, Rundle, and Rocky Mountain formations. The succession differs in several respects from that of the type region at Banff, these variations being, in part, of economic interest.

The Banff formation is Kinderhookian in age. The Rundle formation is raised to group status to include 3 formations, the Livingstone, Mount Head, and Etherington. The Livingstone formation, of Osagean age, is divided into 2 members, Pekisko and Turner Valley, and the latter into the following groups of beds - Banner, Dark Limestone, Lower Porous, Middle Hard, and Upper Porous beds. The Mount Head formation of Meramecian age contains the following members - Wileman, Baril, Salter, Loomis, Marston, and Carnarvon. The Etherington formation, Chesterian in age, is divided into 3 parts. Only a few feet of strata are assigned to the Rocky Mountain formation which may be of Pennsylvanian or Permian age.

The Mississippian succession throughout the southern foothills of Alberta resembles that of the Mount Head area. Its division into several formations and members permits detailed correlation and study of the lateral variations of the beds. --Auth.

1-1656. Raasch, Gilbert O. UPPER PALEOZOIC SECTION AT HIGHWOOD PASS, ALBERTA: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 190-215, map, sec., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 14 refs.

Mississippian and Permian beds in an area in the eastern Rocky Mountains of Alberta are presented in the form of 2 overlapping sections constituting over 2,200 ft. of strata. The Mississippian time span embraced extends from early Osagean through late Chesterian and corresponds to the Rundle group. The Permian deposits are of Leonardian to Guadalupian age and comprise the Rocky Mountain group (redefined).

The Rocky Mountain group is divided into the Storm Creek formation (503 ft.) above, and the Norquay formation (192 ft. below). Two faunizones are discriminated.

The Rundle group is divided into 3 formations, in descending order - the Tunnel Mountain (601 ft.), Mount Head (580 ft.), and Livingstone (920+ft.). These are subdivided into 4, 5, and 5 members, respectively. Nine faunizones are indicated in the Rundle succession, on the basis of which the Tunnel Mountain formation may be correlated with the Chesterian, the Mount Head formation with the Meramecian, and the Livingstone with the Osagean.

The Highwood Pass sections are so located as to assist greatly in local correlations between Banff and Mount Head, the type areas for many of the late Paleozoic units of the region. --Auth.

1-1657. Harker, Peter, and Gilbert O. Raasch. MEGAFAUNAL ZONES IN THE ALBERTA MISSIS-

SIPPIAN AND PERMIAN: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 216-31, 11 illus. on pl., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 16 refs.

Seventeen faunal zones are discriminated and named from the more than 4,000 ft. of strata lying between what is conventionally regarded as the top of the Devonian and the base of the Mesozoic in Alberta. Of these zones, 2 are of Permian age, 14 are Mississippian, and the earliest is either Mississippian or Devonian.

Within the Mississippian, the Spirifer leidyi, Spirifer increbescens, and Dictyoclostus inflatus zones fall within the Chesterian; faunas from the Faberophyllum leathamense zone down through the Ekvasophyllum inclinatum zone are Meramecian; those from the Spirifer keokuk through the Camarotechia cobblestonensis zone Osagean, and the remainder, with the possible exception of Zone I, are Kinderhookian.

Zones from the second through the sixth from the base are grouped in the proposed Banff series, and the remaining Mississippian zones in the Rundle series, corresponding to the Banff formation and Rundle group at the type locality, Mount Rundle, Banff, Alberta, respectively. --Auth.

1-1658. Loranger, D. M. MISSISSIPPIAN MICROPALEONTOLOGY APPLIED TO THE WESTERN CANADA BASIN: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 232-43, 10 figs. incl. 4 maps, 4 secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 11 refs.

Mississippian sedimentary rocks in Western Canada contain abundant microfossil material which can be effectively used to correlate and interpret the geology in this area. Three of these zones characterized by the key ostracode genera Richterina, Cribroconcha, and Paraparchites, are selected to demonstrate their practical application in solving structural and stratigraphic problems. The lowermost zone of the sequence Richterina sp. has restricted distribution within northwestern Alberta and illustrates some of the facies changes within these zones. The middle zone Cribroconcha sp. has been found in the basal Rundle or its equivalents in northwestern, central, and southern Alberta and also in the Mission Canyon of Saskatchewan, Manitoba, and North Dakota. This zone represents one of the first regionally distributed Mississippian faunas and is associated with varying lithologies dependent on basin position. The uppermost Paraparchites carbonarius zone has wide regional distribution and has been subdivided into a lower Glyptopleurina sp. and an upper Bythocypris marginifera zone. The zones are present in normal marine facies throughout the basin, except within southern Saskatchewan and the Williston basin where they occur in the restricted and evaporitic facies of the Charles formation.

The zones have practical application in discovering or verifying the presence of Rundle overlap in northwestern Alberta. The behavior of these zones over shelf areas and the changes within the zones are of use in determining facies changes and the depositional environments of these sediments. Widespread geographic distribution of the upper zones and subzones provide a means of correlating the Mississippian beds of the entire Western Canada basin. --Auth.

1-1659. Harker, Peter, and D. J. McLaren. THE DEVONIAN-MISSISSIPPIAN BOUNDARY IN THE ALBERTA ROCKY MOUNTAINS: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 244-59, 2 illus., map, sec., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 16 refs.

Over most of the Alberta Rocky Mountain region, the Palliser formation, containing an Upper Devonian fauna, is overlain by the Exshaw formation. In its fullest development, the Exshaw consists of 3 members - a thin basal sandstone, overlain by a black shale, which grades into an upper calcareous siltstone. It rests on the Palliser with disconformity; the upper member grades into the Banff formation of Mississippian age. The Exshaw, though widespread, is not present throughout the region, and in some sections the Banff rests disconformably on the Palliser.

The Exshaw corresponds lithologically with the lower 2 members of the subsurface Bakken formation, and similar correspondence is shown between the Exshaw and the Sappington formation of southwestern Montana if the Sappington is interpreted to include the black shale below the sandstone.

The Exshaw fauna has been considered Devonian, but faunal evidence of age is inconclusive. Some forms resemble specimens from the Louisiana limestone of Missouri. An early Kinderhookian fauna has been reported from the Sappington.

It is suggested that the Devonian-Mississippian junction lies at the base of the Exshaw formation in the Alberta Rocky Mountains. --Auth.

1-1660. Penner, D. G. MISSISSIPPIAN STRATIGRAPHY OF SOUTHERN ALBERTA PLAINS: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 260-88, 7 maps, 4 secs., table, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 13 refs.

The Mississippian strata of Southern Alberta plains region, known only from the subsurface, are described as to lithology, thickness, rock units, their correlation with adjacent areas, and history of deposition.

The Mississippian section thins from W. to E. due to post-Paleozoic erosion and to a lesser degree by reason of depositional thinning. In the extreme western part of the map area, there remains approximately 1,500 ft. which is one third of the total Mississippian exposed in the mountains.

The rock units and member names introduced and defined by Douglas in 1953 and the more recently amended subdivisions and new names being proposed by the Mississippian Committee for the foothills area in the vicinity of Turner Valley oil field are defined, for adjacent Plains region, in the Shell-Anglo Canadian Pine Creek well. The formation names, Bakken, Banff, Pekisko, Shunda, Turner Valley, and Mount Head, are used in this general area. It is further proposed to introduce the name Elkton for the commercial gas zone of the Great Plains, Canadian Superior et al., Elkton No. 16-13 well. This zone is regarded as the correlative of the "Crystalline" and "Lower Porous" zones of Turner Valley field usage.

The correlation of these rock units is illustrated on cross sections from the Shell-Anglo Canadian Pine Creek well to the NE., toward the Big Valley oil field, SE. to Saskatchewan, and S. to Kevin-Sunburst area in Montana. The Banff strata of the

Shell-Anglo Canadian Pine Creek well are correlated with the combined MC and MB_2 (Lodgepole) of the Kevin-Sunburst area; the Pekisko and Shunda formations, plus Elkton member of Turner Valley formation, with MB_1 (Mission Canyon); and the upper part of the Turner Valley with the MA unit as defined by Sloss and Laird.

The typical lithological units of the Bakken formation of Montana and the Dakotas are present in the southeastern part of the map area. Pre-Mississippian epeirogenic uplift has caused thinning of the Bakken formation to near zero toward the W. To the N., only the lower black shale is present as a distinguishable rock unit to which the name Exshaw is applicable. The upper part of the formation changes to gray shale which is not readily distinguished from the overlying Banff shale. --Auth.

1-1661. Macauley, George. LATE PALEOZOIC OF PEACE RIVER AREA, ALBERTA: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 289-308, 2 maps, 6 cross secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 16 refs.

Stratigraphic cross sections illustrate lithology, facies, general thickness changes, and rock units of the Mississippian strata which are known in the subsurface in the Peace River area.

Mississippian sedimentary rocks were truncated to the NE. and E. by post-Mississippian pre-Permo-Pennsylvanian erosion. Erosion occurred in 3 additional periods in the more easterly and northerly parts of the area - in pre-Triassic, pre-Jurassic, and pre-Cretaceous time. More than 3,000 ft. of sedimentary rocks remain in the thickest known section and represent all the Mississippian units recognized in surface sections of the Rocky Mountains. More than 1,000 ft. of strata present in the British Columbia subsurface have been eroded in the Peace River area of Alberta.

Several of the formations of the central plains and foothills are recognizable. The Exshaw of the Sturgeon Lake district is a shale-siltstone-limestone sequence which grades northward to shale. The Banff formation, which at the S. is a carbonate unit overlain by a clastic zone, thickens to the N. where a shale facies is present. Similarly the Pekisko of the northern part of the Peace River area is a dark shale, in contrast to the bioclastic limestone facies throughout the rest of Alberta. The Shunda is composed of a series of bioclastic limestones and gray shales over the entire area.

A new formation name, the Debolt, is here proposed for a sequence of rocks divided by a thin clastic zone into a 300-ft. lower unit of fragmental limestones, probably correlative with the Turner Valley of southern Alberta, and a 500-ft. unit of dolostones with evaporites, possibly equivalent to the Mount Head. Amerada Crown "G" F 23-11 has been chosen as the type well section of the Debolt.

Above the Debolt is a series of clastics with some carbonates and evaporites considered to be correlative with the Tunnel Mountain. These beds are assigned to the Stoddart, a new formation proposed by Rutgers.

The Pekisko, Shunda, and lower Debolt comprise Laudon's Dessa Dawn of the Wapiti Lake surface sections.

The "Permo-Pennsylvanian" beds, indefinite as to age, are composed of light-colored chert, dense dolostones, and quartz-chert sandstones. Considerable erosion of the Stoddart and Debolt indicates a major unconformity and time lapse before deposition of the "Permo-Pennsylvanian" over the Mississippian. --Auth.

1-1662. Patton, W. J. H. MISSISSIPPIAN SUCCESSION IN SOUTH NAHANNI RIVER AREA, NORTHWEST TERRITORIES: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 309-326, 2 illus., 4 pls., 2 maps, 2 cross secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 17 refs.

A thick section of Mississippian rocks is exposed W. of Jackfish River in the LaBiche Range of the Mackenzie Mountains near South Nahanni River, Northwest Territories, Canada. Location is 61°06'N. 123°59'W.

From fossil evidence rocks of Kinderhook, Osage, Meramec, and Chester age are known to be present.

Strata with a Kinderhook fauna equivalent in age to the Banff formation are of a similar lithology to southern sections, but equivalent Rundle strata with Osage, Meramec, and Chester fossils consist of interbedded argillaceous limestone and calcareous shale overlain by a great thickness of sandstones with minor shale and coal beds. Fossil plants Stigmaria sp. and Lepidodendron sp. and coal were found in sandstones below the Meramecian Spirifer cf. pellaensis zone.

The name Mattson formation is introduced for the thick sandstone sequence of nearshore environment which overlies the typical Banff formation lithology of interbedded argillaceous limestones and shales.

Microspores from the coal of the Mattson were identified by P. A. Hacquebard of the Coal Research Branch of the Geological Survey of Canada, Sydney, Nova Scotia, and were found to indicate a lower Carboniferous flora. Spores in the coal are unlike those found in Mississippian coal of Utah, but are very similar to those described by the Russians from the Carboniferous of the Ukraine. --Auth.

1-1663. Rutgers, A. T. C. STODDART FORMATION OF NORTHEAST BRITISH COLUMBIA: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 327-30, 2 figs. incl. maps, logs, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) ref.

The name Stoddart formation is here proposed for a succession of late Paleozoic strata lying above the Rundle limestone with apparent conformity in Pacific Fort St. John No. 23 gas well. The overlying formation is usually referred to as Permo-Pennsylvanian, but the precise age is unknown.

The formation can be divided into a lower unit 1,250 ft. thick which is predominantly clastic, and an upper unit 910 ft. thick, mainly of carbonate rocks.

No fossil evidence of age is available. In other wells the Stoddart formation is represented only in part, and in the type well section the Stoddart may have suffered some erosion. --Auth.

1-1664. Edie, Ralph W. MISSISSIPPIAN SEDIMENTATION AND OIL FIELDS IN SOUTHEASTERN SASKATCHEWAN: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 331-63, 6 illus. on pl., 18 figs. incl. 10 maps, 5 secs., 7 tables,

Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 30 refs.

Marked facies changes occur in the Mission Canyon and lower part of the Charles formation (Mississippian) in southeastern Saskatchewan. Northeastward from the basinal area, 4 successive environments of deposition with characteristic rock types and fossils may be mapped as follows.

1. Basin - dark brown-gray argillaceous limestone containing scattered white crinoid columnals, black bituminous shale partings, and brownish gray chert.
2. Open marine shelf - cream-white fossiliferous-fragmental and chalky limestones containing crinoids, bryozoans, brachiopods, and zaphrentid corals.
3. Barrier bank - cream-white precipitated limestones including pisolitic, oölitic, pseudo-oölitic, and lithographic types. Fossils include abundant algae and few scattered gastropods.
4. Lagoon - cream-white chalky argillaceous limestone containing ostracods, earthy to sucrosic secondary dolomite and anhydrite.

Evaporitic (primary?) dolomites occur in the upper Charles as a result of basinwide evaporitic conditions. These typically dense (cryptocrystalline) and nonporous dolomites are closely associated with anhydrite.

Factors which control porosity in the limestones include sorting of fossil debris or precipitated calcareous grains, submarine erosion and redeposition of partially lithified calcareous muds, solution, dolomitization?, fractures, compaction, and infilling of pores by calcite, anhydrite, or chert.

Stratigraphic trap oil accumulations occur where permeable units of the Mission Canyon and Charles are truncated and overlain by pre-middle Jurassic red beds. Factors affecting oil accumulation include the presence of the following.

a. Permeable reservoir beds at or near the unconformity.

b. Anhydrite filling pores where the permeable reservoir beds are truncated by the pre-Jurassic erosion.

c. Anhydrite beds conformably overlying and underlying the permeable units and thus forming a roof and floor for the reservoir beds.

d. Topography of the Mississippian erosion surface.

Mississippian strata in the oil-producing area of southeastern Saskatchewan are characterized by the following.

1. Relatively steep dips (40-60 ft. per mi.) as compared with dips of 10-20 ft. per mi. in much of southwestern Saskatchewan.
2. Relatively rapid truncation (15-40 ft. per mi.) as compared with an average of approximately 5 ft. per mi. in southwestern Saskatchewan.
3. Relatively saline waters (50,000-150,000 p. p. m. of chloride-ion content) as compared with 100-8,000 p. p. m. in southwestern Saskatchewan.

In exploration for new trends or extensions of known producing areas, important consideration should be given to the distribution of permeable rock facies within individual stratigraphic units. In addition, it is possible to predict the location of topographically high trends as the various lithologic types are differentially resistant to erosion. For example, the precipitated barrier bank limestones are relatively resistant to weathering and form topographic ridges in the Nottingham field. The lower limit of oil accumulation within reservoir beds may be determined by the location of a spill point, in turn controlled by the downdip limit of lagoonal anhydrite floors. --Auth.

1-1665. Porter, J. W. MADISON COMPLEX IN SOUTHEASTERN SASKATCHEWAN - SOUTHWESTERN MANITOBA: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 364-71, 3 cross secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 6 refs.

This paper illustrates the facies problem in the Madison [Mississippian] of southeastern Saskatchewan and southwestern Manitoba.

A brief history of the derivation and application of the terminology serves as an introduction to the more detailed analysis of conditions of deposition as revealed by a lithofacies study.

The subcrop of porous horizons in the Madison on the Paleozoic erosion surface influences oil accumulation in southeastern Saskatchewan and southwestern Manitoba. --Auth.

1-1666. Stanton, M. S. STRATIGRAPHY OF THE LODGEPOLE FORMATION, VIRDEN-WHITEWATER AREA, MANITOBA: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 372-90, map, 3 secs., log, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) ref.

Increasing importance of the Virden-Roselea and North Virden oil-productive area has made it desirable that a workable subdivision of Lodgepole stratigraphy be undertaken for this area and for adjoining regions wherever correlation can be extended. The present paper proposes a stratigraphic subdivision of Mississippian Lodgepole of the Virden-Whitewater region into units of member rank, which are herein described and named in ascending order, the Scallion, Virden, and Whitewater Lake members. In addition, a fourth unit of limited preserved geographic extent is herein described and named the Routledge shale.

Due to lithologic variations resultant from changes in depositional environment within the preserved portion of the Lodgepole of the eastern Williston basin, the proposed stratigraphic units are applicable in general only to the eastern portions of the Manitoba and northern North Dakota sections. Recognizable correlation becomes increasingly difficult and unreliable westward of a northerly trending narrow zone of demarcation. The proposed subdivision into units of member rank is applicable throughout about 2,500 sq. mi. in the Canadian area of study. Despite the limited regional extent of application, the economic importance of the area, including as it does the Virden-Roselea, North Virden, Southwest Virden, Routledge, South Regent, Whitewater, and Lulu Lake fields, warrants stratigraphic subdivision. --Auth.

1-1667. Reasoner, M. A., and A. D. Hunt. STRUCTURE OF COLEVILLE-BUFFALO COULEE AREA, SASKATCHEWAN: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 391-406, 8 figs. incl. 5 maps, 2 cross secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 20 refs.

Contour maps, a paleogeological map, and cross sections are presented to demonstrate the structure of the area. Lower Paleozoic structure is briefly discussed. All structures observed in the uppermost Devonian and Lower Mississippian strata are attributed to leaching of a thick Upper Devonian anhydrite member with consequent collapse of overlying beds. The

drainage pattern of an old land surface developed by a post-Mississippian erosional period is outlined, and all structures in the Cretaceous are shown to be the result of compaction and draping over this old land surface. The limitations this erosional unconformity place on seismic interpretations are explained. Unconformable contact between the Mississippian Coleville sand and Cretaceous shale probably accounts for the entrapment of oil in the sand. --Auth.

Discussion by T. A. Link, p. 405-406.

1-1668. Andrichuk, John M. MISSISSIPPIAN MADISON STRATIGRAPHY AND SEDIMENTATION IN WYOMING AND SOUTHERN MONTANA: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 407-449, 6 maps, 8 cross secs., Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 77 refs.

Madison sediments accumulated in 2 depositional realms - a basinal, predominantly limestone province in Montana and adjoining Dakotas; and the Wyoming shelf, characterized by prominent dolomitization on the S. The belt of transition in southern Montana and adjoining South Dakota showed relatively little migration throughout deposition. W. of the Wyoming shelf, limestone and shale deposition took place in the Idaho geosynclinal trend. Southeastward to the Cambridge arch, Madison sediments were affected by increasing amounts of pre-Pennsylvanian erosion in Wyoming and western South Dakota. Mississippian sediments are absent from a part of southeastern Wyoming.

Early, medial, and late stages of sedimentation may be differentiated on the basis of lithologic cycles or sequences developed in the Madison group. Early sedimentation was characterized by deposition of the approximate Lodgepole formation and equivalents, Guernsey, Englewood, and lower Pahasapa formations. Deposition commenced earliest in the Williston basin and central Montana trough with the development of black shales, followed by dense limestone and shales; minor terrestrial to nearshore marine clastic sedimentation in the Black Hills area commenced somewhat later, preceding and accompanying the initial marine transgression on the Wyoming shelf. Widespread deposition of normal marine and fragmental oölitic limestones (mainly dolomitized equivalents in the shelf areas) occurred. Shoaling was prominent, and as a result local minor restricted deposition took place.

Marine limestone and dolomite sedimentation, modified by 2 episodes of evaporite precipitation, occurred during medial Madison time. Mission Canyon carbonates containing an intermediate evaporite zone and overlain by the prominent basal Charles evaporites constitute the resulting middle unit. Evaporitic deposition was characterized by the precipitation of anhydrite and halite in the basinal areas at the N. Southward, progressively less restriction is demonstrated by the disappearance of halite, thinning of anhydrite, and the development of primary dense carbonate zones.

Late sedimentation was characterized by restoration of normal marine conditions and development of a complex evaporite cycle (Charles formation, excluding basal evaporites).

Big Snowy clastics were deposited in Chester time in the northern basinal areas. In other areas, pre-Amsden or pre-Pennsylvanian to pre-Middle Jurassic erosion had varying effects on the Madison surface.

Limestone reservoirs in the basinal areas of Montana and North Dakota, and dolomites in northwestern Wyoming yield Madison oil. Optimum facies changes and postdepositional tectonic effects make the Madison group an excellent prospective unit in many areas. --Auth.

1-1669. Law, J. GEOLOGY OF NORTHWESTERN ALBERTA AND ADJACENT AREAS: (In: Goodman, A. J., ed. Jurassic and Carboniferous of Western Canada, with Related Papers; a Symposium...: p. 450-99, 2 illus., 9 maps, cross sec., diag., log, table, Tulsa, Oklahoma, American Association of Petroleum Geologists, 1958) 33 refs.

The area forms part of the Interior Plains of Canada. Cretaceous shales thicken from nothing in the NE. to 3,000 ft. in the SW. where they rest unconformably on wedges of Triassic shales and sandstones underlain by Permian or Pennsylvanian sandstones and dolomites. The latter in turn rest unconformably on Mississippian limestones and shales. The Upper Devonian is truncated in the E., where it is overlain by the Cretaceous, but attains a thickness of 3,200 ft. in the W. The upper part consists of limestones for which the use of the group name Wabamun is extended from central Alberta. This group overlies silty limestones. The lower part of the series consists of interbedded shales, siltstones, and limestones; a thick limestone section occurs in the E. and a reef complex is present in the SE. The Middle Devonian has maximum thickness of 1,600 ft. and consists of the Slave Point formation and the Elk Point group. The former consists of limestone with an anhydritic member and rests, probably disconformably, on the Elk Point, which can be subdivided into a clastic unit, an upper evaporitic unit, a carbonate unit, and a lower evaporitic unit. The formational names, Watt Mountain, Muskeg, Keg River, and Chinchaga, are proposed for these units. The upper evaporitic unit passes northward into the Presqu'ile dolomite of the Great Slave Lake area. This dolomite is interpreted as forming a barrier reef. A barrier reef was also present in northwestern Alberta. The Middle Devonian rests on red beds of doubtful age which in turn overlie Precambrian granite. The regional structure is homoclinal with gentle dips W. or SW., but there is some evidence of local structure.

Facies studies were used to forecast areas of favorable reservoir rock. Oil and gas showings occur in the northern part of the area where there are chances of commercial production. --Auth.

Discussion by C. W. Hunt and reply by J. Law, p. 496-99.

1-1670. Forgotson, James M. THE BASAL SEDIMENTS OF THE AUSTIN GROUP AND THE STRATIGRAPHIC POSITION OF THE TUSCALOOSA FORMATION OF CENTRAL LOUISIANA: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 117-25, 7 figs., 1958, 16 refs.

Stratigraphic relationships in the lower part of the Upper Cretaceous Gulf series are demonstrated with electric well log cross sections extending from the E. Texas basin, along the S. flank of the Sabine uplift and across central Louisiana.

The Austin group lies with angular unconformity on formations as old as undifferentiated Fredericksburg-Washita groups over the S. flank of the Sabine

uplift. West of this uplift, chalk equivalent to the Ector constitutes the base of the Austin, but E. of it a shale section as much as 400 ft. thick occurs conformably beneath the Ector and on top of the regional unconformity. The name Rapides shale is proposed for this section, which is considered the basal unit of the Austin group. The stratigraphic relations of the E. Texas Woodbine and central Louisiana Tuscaloosa groups are similar; the latter is correlated specifically with the Lewisville formation at the top of the Woodbine because of lithologic similarity. --D. C. Van Siclen.

1-1671. Paine, William R. FRIO SEDIMENTATION PATTERNS IN ACADIA AND JEFFERSON DAVIS PARISHES OF LOUISIANA: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 101-103, 4 figs., 1958, 4 refs.

The Frio (Oligocene) sediments of Acadia and Jefferson Davis parishes, southwestern Louisiana, exhibit 2 distinctive types of sedimentation. In the "Nodosaria embayment" of Acadia Parish, the lower and middle Frio thickens tremendously on the downthrown side of at least 4 major down-to-the-coast fault zones. These faults are progressively younger from N. to S., and the maximum sedimentation on each downthrown block took place at the time of fault movement.

The proportion of sand in the interval from the Marginulina texana zone down to the base of the highest Nodosaria blanpiedi sand remains about constant despite the great thickening on downthrown blocks. However, the interval thickness and net sand thickness within each block is related to structural features. In the 2 more northerly downthrown fault blocks the thickest net sand coincides with the top of the structural "highs." However, on the downthrown side of the third fault zone thicker sands accumulated close to the fault as well as on the crest of the "highs." S. of the fourth major fault the net sand thickness is at its maximum near the fault and decreases on top of the structure. Sedimentation in this interval is interpreted to have taken place under relatively stable shelf conditions in the 2 more northerly fault blocks, changing to unstable shelf farther S.

In contrast, in the upper Frio Camerina zone of southern Jefferson Davis Parish, where similar marked thickening occurs on the downthrown side of major faults, there is a marked concentration of sands in the NE. corner of each downthrown block. The proportion of sand in each block decreases westward and southward and shows little or no relationship to the top of structural "highs."--D. C. Van Siclen.

1-1672. DuBar, Jules R. NEOGENE STRATIGRAPHY OF SOUTHWESTERN FLORIDA: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 129-55, 14 figs., 5 tables, 1958, 53 refs.

In southern Florida the Caloosahatchee marl rests unconformably on the argillaceous marls and sands of the Tamiami formation (late Miocene). The Caloosahatchee is composed of a thin succession of shallow-water marine and brackish-water marls, sandstones, and limestones, and a few thin beds of fresh-water origin.

The Caloosahatchee marl is divided into 3 members. The lowest member, The Ft. Denaud, and the uppermost member, the Ayers Landing marl, were deposited near to shore, whereas the middle member, the Bee Branch, was deposited offshore in relatively deep water.

The Caloosahatchee marl heretofore considered Pliocene in age is assigned to the Pleistocene epoch. The most compelling evidence favoring this revised age assignment is that of the Pleistocene vertebrate fossils contained in the marine deposits in the type area. The presence of Equus (Equus) sp. cf. (E.) leidyi and Holmesina septentrionalis is regarded as strong evidence for a post-Kansan age. Paleogeographical and paleoecological studies indicate that the formation was deposited during the making of the Wicomico shoreline (100 ft. above sea level) generally regarded as of Sangamon age.

The Ft. Thompson formation unconformably overlies the Caloosahatchee marl and is regarded as Wisconsin in age. The Ft. Thompson was possibly deposited during a temporary recession of the Wisconsin glaciers. Paleogeographical and paleoecological studies suggest that the Ft. Thompson formation should be correlated with the making of the Pamlico shoreline (25-30 ft. above sea level).

The overlying Pamlico sands may represent littoral sediments deposited from the retreating Ft. Thompson sea. The Lake Flirt marl is a very recent deposit. --Auth.

1-1673. Johnson, Frederick. A BIBLIOGRAPHY OF RADIOCARBON DATING: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 199-214, 1959.

Approximately 375 references are listed alphabetically by author under 6 main headings: 1) lists of dates; 2) the method: techniques and geochemistry; 3) the method: explanatory essays; 4) interpretation: selected geologic titles; 5) interpretation: selected archeologic titles; 6) bibliographies and reports on conferences.

In the first section, in addition to formal lists of dates are titles reporting dates not yet published in a list.

The primary heading is "method." Under this heading have been entered titles of articles which contributed to the development and recent ramifications of the method, including analyses of cosmic ray flux, the carbon dioxide cycle, phenomena related to atomic bomb explosions, discussions of instrumentation, etc.

An attempt has been made in this bibliography to provide a significant title for every area which has been the subject of chronological study; also titles which represent different types of discussion or ideas concerning the manner in which dates may be employed. --A. C. Sangree.

1-1674. Heusser, Calvin J. RADIOCARBON DATES OF PEATS FROM NORTH PACIFIC NORTH AMERICA: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 29-34, 1959, 14 refs.

Ages are presented for 17 late-Pleistocene peat samples from sections that range from Karluk on Kodiak Island, Alaska, to Port Orford, Oregon. Pollen and peat stratigraphy of the sections is used to interpret the environments prevailing at and since the time of sample deposition. The late-glacial at more southerly Pacific coastal Alaskan sites is dated at ca. 10,800 B. P. and the postglacial at ca. 10,000 B. P. At northerly coastal sites these intervals begin somewhat later. Regression rates for sea level are given for a number of sites along this coast. Sample ages from 2 Oregon lakes suggest eustatic transgression ca. 5,000 B. P. during the Hypsithermal interval. --Auth.

1-1675. Shutler, Dick, Jr., and Paul E. Damon. UNIVERSITY OF ARIZONA RADIOCARBON DATES II: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 59-

62, 1959, 4 refs.; also pub. as: Arizona, Univ., Program in Geochronology, Contr. no. 10.

The radiocarbon age measurements reported here were made during May 1957-May 1958. This is the final list of solid carbon dates that will appear from the laboratory, as the solid carbon method is being discontinued in favor of the carbon dioxide gas method. Techniques are briefly described. The 9 samples listed and described are from Arizona, Wisconsin, and the Netherlands. --A. C. Sangree.

1-1676. Olson, Edwin A., and Wallace S. Broecker. LAMONT NATURAL RADIOCARBON MEASUREMENTS V: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 1-28, 1959, 51 refs.

Previously published in American Journal of Science and listed as GeoScience Abstracts 1-389.

1-1677. Broecker, Wallace S., and Edwin A. Olson. LAMONT RADIOCARBON MEASUREMENTS VI: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 111-32, 1959, 23 refs.; also pub. as: Columbia Univ., Lamont Geol. Observatory, Contr. no. 340.

In contrast to previous radiocarbon measurement lists, this list contains only known-age samples, most of which formed during the past 10 years. The measurements were made largely in order to gain an understanding of the distribution of radiocarbon within the dynamic carbon reservoir both today and at times in the past. Since all materials forming in this reservoir today do not have the same C^{14}/C^{12} ratio, such an understanding is necessary in order to arrive at the most accurate possible estimate of the age of samples submitted for dating. This is particularly important when high accuracy (i.e., <100 years error) is required on subaerially grown samples and also when attempting to extend the method to samples which formed in reservoirs other than the atmosphere (for example, the ocean and fresh-water systems).

The data in this list are not reported with the idea of drawing new conclusions, for such conclusions as are possible have been reported elsewhere. However, republication in such a list as this has the following advantages: (1) if all laboratories summarize their measurements in this manner, the world data on C^{14}/C^{12} ratios in contemporary materials will be brought together in one place, in the same form, and in the same system of units; (2) by referencing the technical articles in which the data are discussed, the lists will act as a bibliography for such literature; (3) the summaries will be transferred directly to the punch cards published by Radiocarbon Dates Association, Inc., allowing a more complete and uniform coverage of the available data; and (4) such lists encourage the publication of isolated measurements which might otherwise remain in the files of individual radiocarbon laboratories. --Auth.

The 73 samples listed and described are from the United States, Guatemala, Italy, Algeria, Australia, Mediterranean Sea, and North and South Atlantic.

1-1678. Ralph, Elizabeth K. UNIVERSITY OF PENNSYLVANIA RADIOCARBON DATES III: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 45-58, 1959, 25 refs.

Primary function of the Radiocarbon Laboratory at the University of Pennsylvania is to date archeological samples from the 4 regions of the world in which University Museum studies are concentrated: the Near East, South America, Central America, and the Arctic. Dates for sites in the first 2 regions are included in this list. At the end of 1955 the Laboratory changed to the proportional counting of pure carbon dioxide technique. Some notes are given on methods. The 78 samples listed and described are from Turkey, Egypt, Saudi Arabia, Iran, West Pakistan, India, Venezuela, Bolivia, and Peru. --A. C. Sangree.

1-1679. Deevey, Edward S., L. J. Gralenski, and Väinö Hoffren. YALE NATURAL RADIOCARBON MEASUREMENTS IV: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 144-72, 1959, 105 refs.

Dates obtained since the last date list (Yale Natural Radiocarbon Measurements III), and up to the end of 1958, are given. All are based on duplicate measurements of carbon dioxide in a proportional counter. The 109 samples listed and described are from Canada, United States, South America, Central America, British West Indies, Cuba, Spain, Australia, North Borneo, Red Sea, and Africa. --A. C. Sangree.

1-1680. Crane, H. R., and James B. Griffin. UNIVERSITY OF MICHIGAN RADIOCARBON DATES IV: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 173-98, 1959, 64 refs.

The following is a list of radiocarbon dates obtained since the time of the preparation of Michigan list III. The description of the essential features of our method of measurement as given in the introduction to list III applies to this list. The modern standards used were obtained from hardwood logs, and were of various ages from 75 to 150 years by ring count. These standards were sufficiently old so that no correction for the recent dilution of the atmospheric C^{14} is believed to be necessary in the dates reported here. The ages of carbonate sample are also calculated from modern wood as a reference standard, without any correction for isotope fractionation. --Auth. introd.

The 112 samples listed and described are from the United States, Canada, Greenland, West Indies, Central and South America, North and South Pacific Ocean areas.

1-1681. Barker, H., and C. J. Mackey. BRITISH MUSEUM NATURAL RADIOCARBON MEASUREMENTS I: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 81-86, 1959, 17 refs.

The first series of radiocarbon dating measurements made at the British Museum Research Laboratory are reported and techniques are noted. The 14 samples listed and described are from England, Italy, Egypt, United States, Denmark, South Africa, and British Honduras. --A. C. Sangree.

1-1682. Godwin, H., and E. H. Willis. CAMBRIDGE UNIVERSITY NATURAL RADIOCARBON MEASUREMENTS I: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 63-75, 1959, 26 refs.

The dates given were obtained up to the end of Dec. 1958. They were made with carbon dioxide at 2 atmospheres pressure in a proportional counter of about 2-liter volume. The samples were all taken in conjunction with pollen-analytic, stratigraphic, or other Quaternary investigations. The 62 samples listed and described are primarily from the British

Isles. One sample is from the Persian Gulf, another from Italy. --A. C. Sangree.

1-1683. Nydal, R. TRONDHEIM NATURAL RADIOCARBON MEASUREMENTS I: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 76-80, 1959, 18 refs.

The C^{14}-dating laboratory in Trondheim, Norway, has been in operation for a year and a half. The present dating list covers the period July 1957-Sept. 1958. The 14 samples listed and described are from Norway and Sweden. --A. C. Sangree.

1-1684. Östlund, H. Göte. STOCKHOLM NATURAL RADIOCARBON MEASUREMENTS II: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 35-44, 1959, 18 refs.

This paper is a list of the radiocarbon datings of geologic and archeologic samples made during 1958 after the dating apparatus had been installed at the Geological Survey [of Sweden]. It is a direct continuation of the first dating list. Some of the results of geophysical interest, measurements of a few sea water samples, have been published separately; others will follow. --Auth. introd.

The 60 samples are from Sweden, Egypt, Italy, and Cyprus.

1-1685. Olsson, Ingrid. UPPSALA NATURAL RADIOCARBON MEASUREMENTS I: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 87-102, 1959, 58 refs.

This list covers the samples measured at the Uppsala radiocarbon laboratory during 1957 and 1958. Pretreatment is briefly described. The 73 samples listed and described are from the Mediterranean area, Iceland, Svalbard, Norway, Sweden, Denmark, Netherlands, Germany, India, and Egypt. --A. C. Sangree.

1-1686. Oeschger, H., U. Schwarz, and Chr. Gfeller. BERN RADIOCARBON DATES I: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 133-43, 1959, 17 refs.

This list covers the measurements made at the University of Bern up until summer 1958.

The samples are converted into acetylene and measured at a pressure of nearly 1 atmosphere. Peat samples have been pretreated by washing with hot dilute hydrochloric acid. Bone samples have been charred before the treatment with acid. As modern reference standard the mean radiocarbon content of several wood samples, formed between A. D. 1850 and 1900, has been used. The errors given are the standard deviations derived from the number of counted particles and the statistical errors of background and standard.

If no significant net effect differing by $> 2\sigma$ from background has been measured, the minimum age has been calculated from the background plus 2σ.

The list is divided into 2 groups. The first consists chiefly of samples related to the history of vegetation in the northern and southern Swiss Alps, the second of archeologic samples, mainly from lake dwellings. --Auth introd.

The 67 samples listed and described are from Switzerland, Austria, and Italy.

1-1687. Ferrara, G., M. Reinharz, and E. Tongiorgi. CARBON-14 DATING IN PISA: Am. Jour. Sci. Radiocarbon Supp., v. 1, p. 103-110, fig., 1959, 14 refs.

A laboratory was set up at the University of Pisa, Italy, for the study of geologic and paleontologic problems. A mass spectrometer for paleotemperature measurements and a carbon-14 dating apparatus were constructed. The first carbon dates are given here, together with a short description of the experimental setup. The 22 samples listed and described are from Italy, Crete, Switzerland, and France. --A. C. Sangree.

5. PALEONTOLOGY

See also: Stratigraphy 1-1657, 1-1658, 1-1662; Sedimentary Petrology 1-1765; Fuels 1-1858.

1-1688. Stirton, Ruben Arthur. TIME, LIFE AND MAN; THE FOSSIL RECORD: 558 p., 291 figs. incl. illus., maps, diags., cross secs., New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1959, 246 refs.

The book is designed primarily as a text for a course in introductory paleontology, although most of it is intended also for the interest of general readers. It is written to arrest the attention of students with little or no training in the biological and earth sciences, yet for more advanced students brings into focus the overall picture of paleontology.

The first 5 chapters outline the objectives and general principles to which attention is directed through the book. This is followed by a history of paleontology tracing the changes in concepts and the evolution of thought on the subject as more fossil evidence was discovered and as society gradually became more tolerant of studies on antiquity and evolution of life. The author then presents a simplified classification of the plants and animals, both living and extinct, that are included under each hierarchy; their known geologic range; and some of the important characters used in outlining the scope of the phyla, classes, orders, etc. The core of the book deals with a chronologic presentation of the sequence of life from the Precambrian era to the Pleistocene era. In many respects this section of the book is much like historical geology, but the fossil record is emphasized more than the physical events in the earth's history. The last 9 chapters are based on selected subjects and stress application of the information presented in preceding chapters.

The last 2 sections in the bibliography refer to the more recent publications on correlation charts and citations to bibliographies of fossil plants and animals. --Auth.

1-1689. Imbrie, John. BRACHIOPODS OF THE TRAVERSE GROUP (DEVONIAN) OF MICHIGAN. PART 1. DALMANELLACEA, PENTAMERACEA, STROPHOMENACEA, ORTHOTETACEA, CHONETACEA, AND PRODUCTACEA: Am. Mus. Nat. History, Bull., v. 116, art. 4, p. 349-409, 3 figs., 20 pls., table, 1959.

Twenty-three genera, 98 species, and 11 sub-

species are described and illustrated from abundant and well-preserved material from the Traverse group of Michigan. Fifty-four species and 5 genera (Sphenophragmus, Orthopleura, Oligorhachis, Helaspis, and Truncalosia) are newly proposed. Bivariate statistical techniques are employed as a means of characterizing growth patterns. Unusually abundant and stratigraphically complete collections of several genera from the lower 4 formations of the Traverse group display continuous variation between extreme morphologic types. Theoretical difficulties in the compartmentation of an evolutionary continuum, ordinarily not encountered because of the incomplete nature of the fossil record, are here met in fact. Significant differences are noted in the number of species of the genus Strophodonta found in different formations, with a maximum of taxonomic diversity and a minimum of morphologic variation characterizing collections from the Alpena limestone. This relationship is interpreted in terms of adaptive radiation into a diversity of habitats associated with Alpena reefs. Species ranges within Michigan document the correlation of the Gravel Point formation with the Alpena limestone and part of the Four Mile Dam formation and the correlation of the middle Petoskey formation with the Potter Farm formation. Identification of Traverse species in collections from Illinois, Ohio, Indiana, Ontario, Missouri, and New York contributes to the regional correlation of Traverse strata. --Auth.

1-1690. Mongin, Denise. STUDY OF SOME AMERICAN MIOCENE LAMELLIBRANCHS AND COMPARISON WITH RELATED EUROPEAN SPECIES: Bulls. Am. Paleontology, v. 39, no. 180, p. 283-343, 11 figs., 4 pls., 8 graphs, June 1959, 69 refs.

An analytical study of 30 species of Miocene lamellibranchs from the rich beds of Chesapeake Bay (Maryland and Virginia). A comparison with related forms of western Europe, although furnishing interesting systematic and biologic conclusions, does not establish any equivalents between the Miocene stages of the 2 continents. --Auth.

1-1691. Hoskins, Donald M., and Richard R. Conlin. INVERTEBRATE FOSSILS FROM THE BLOOMSBURG FORMATION OF CENTRAL PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 156-61, 1958, 7 refs.

An ostracod fauna discovered in the "barren" Bloomsburg formation [Silurian] of central Pennsylvania is discussed. Leperditia sp., Halliella sp., Eukloedenella sp., Dizygopleura cf. swartzi, Kloedenia normalis, Zygobeyrichia ventricornis, and Zygobeyrichia sp. were identified.

Many of the specimens of Dizygopleura are conspecific with Dizygopleura swartzi as figured by Ulrich and Bassler and not conspecific with Dizygopleura swartzi as figured by Swartz. Variations from the type of Dizygopleura swartzi to the form of variants occur. It is suspected that individual variations have produced this heterogeneity of forms. Some specimens of Dizygopleura are not conspecific with any described in the literature. More detailed investigation concerning this problem is in progress.

The ostracod fauna found in the Bloomsburg could represent floodings of short time duration of nearshore lagoonal and deltaic areas sufficient to allow a marine faunal incursion. The present study suggests a correlation of the upper McKenzie formation in Maryland with the upper Bloomsburg in central Pennsylvania. --Auth.

1-1692. Puri, Harbans S. OSTRACODE GENUS CUSHMANIDEA: Gulf Coast Assoc. Geol. Soc., Trans. v. 8, p. 171-81, 2 figs., 2 tables, 1958, 44 refs.

Ostracode genus Cushmanidea Blake is redescribed and refigured on the basis of new specimens. Restudy of type species of Cushmanidea and its allied genera show that type species Pontocythere Dubovsky, 1939 (P. tchernijawskii Dubovsky), Hemicytherideis Ruggieri, 1952 (Cytheridea elongata Brady) and Cushmanidea Blake, 1933 (Cytheridea seminuda Cushman) are congeneric; therefore, Cushmanidea being the older name has priority over both Pontocythere and Hemicytherideis. A new genus, Hulingsina, (type species H. tuberculata Puri, n. sp.) is erected to include tuberculate or coarsely pitted neocytherideid species in which the posterior is subacute and the dorsal half of the posterior end is oblique. Two new species of Hulingsina, H. tuberculata and H. sandersi are described from the Recent of the West Coast of Florida and Gulf of Mexico.

The subfamily Neocytherideidinae is revised, a key to the relationships and distinguishing characteristics of the various genera classified under this family is given, and the structure and evolution is discussed. The genus Cushmanidea is thought to have stemmed from Schuleridea stock late in Jurassic times. The development of other neocytherideid genera from Cushmanidea is discussed and their probable origin is shown. The geologic range of Cushmanidea and Hilingsina is shown on 2 charts. --Auth.

1-1693. Puri, Harbans S. OSTRACODE SUBFAMILY CYTHERETTINAE: Gulf Coast Assoc. Geol. Soc., Trans. v. 8, p. 183-89, fig., 2 tables, 1958, 40 refs.

Subfamily Cytherettinae Triebel is emended to include ostracode genera in which the inner margin forms an S-shaped curve in the anteroventral region. So defined the subfamily includes Cytheretta Muller, Paracytheretta Triebel, Pseudocythereis Skogsberg, Protocytheretta Puri, n. gen., and Eucytheretta Puri, n. gen. Protocytheretta is proposed to include forms with Cytheretta-type hinge that show 3 strong longitudinal ribs and a reticulate pattern on the subsurface of the carapace. Eucytheretta is erected to include forms intermediate between Cytheretta and Paracytheretta. --Auth.

1-1694. Cramer, Howard Ross. ADDITIONS TO THE HAMILTON BIOTA AT ROCKVILLE, DAUPHIN COUNTY, PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 184-87, 3 figs., 1958, 5 refs.

The presence of a blastoid, a nautiloid, and spores(?) from the Devonian at Rockville is significant. These fossils add to the rich biota of over 44 species reported by Willard (1939), and represent geographic extensions of the ranges of all of them.

This paper is the first record of a blastoid in Pennsylvania and the first appearance of the coiled nautiloid genus Carlloceras from this part of the state. The spores(?) were not listed by Willard from Rockville, but unidentified spores are mentioned from the nearby section at Barnett's Mill in Perry County. The spores(?) are represented by the same genus from Ohio. --Auth.

1-1695. Richards, Horace G. ORDOVICIAN FOSSILS FROM MONTGOMERY COUNTY, PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p.

139-40, 1958, ref.

Fossils are exceedingly rare in Cambrian and Ordovician limestones in the Philadelphia area. The only published record is that in the Philadelphia Folio (Bascom et al, 1909) where 4 genera were reported from the Shenandoah limestone of Cambro-Ordovician age at Henderson Station in Montgomery County.

Recently in the reorganization of the collections of the Academy of Natural Sciences [Philadelphia], a large slab of siliceous material collected by Louis Woolman about 1894 from Henderson Station was discovered. These are tentatively referred to the genus Maclurea.

Two pieces of similar siliceous rock were found, also collected by Louis Woolman from the Henderson locality. Several of the fossils have been identified by Dr. E. O. Ulrich.

The writer hopes to publish further notes as well as illustrations of these fossils elsewhere in the near future. --Pennsylvania Geol. Survey.

6. GEOPHYSICS

See also: Structural Geology 1-1631; Mineral Deposits 1-1798, 1-1799; Fuels 1-1816.

1-1696. Ballenzweig, Emanuel M. A PRACTICAL EQUAL-AREA GRID: Jour. Geophys. Research, v. 64, no. 6, p. 647-51, 4 figs., table, June 1959, 6 refs.

The deficiencies of various methods used to date for mapping the geographical variation of geophysical quantities are discussed. A method for constructing a practical equal-area grid for use in such work is illustrated. It can be constructed for any scale or map projection and can also be used hemispherically. Its advantages over other methods are discussed. It is suggested that, in lieu of an equal-area grid, it is better to use the raw frequencies in n degree squares than to adjust them by proportionality factors designed to equate the size of the squares to that of the equal-area grid. --Auth.

1-1697. Gerard, V. B. THE PROPAGATION OF WORLD-WIDE SUDDEN COMMENCEMENTS OF MAGNETIC STORMS: Jour. Geophys. Research, v. 64, no. 6, p. 593-96, 2 figs., table, June 1959, 4 refs.

A study of the times of 3 sudden commencements, recorded on Aug. 3, Sept. 21, and Nov. 6, 1957, respectively, at 10 widely-separated magnetic observatories, indicates that when main and preliminary impulses are both recorded at one place (as in the typical SC*) they really begin approximately simultaneously. Therefore, it would appear that in non-tropical regions the rate of growth of the so-called preliminary impulse is usually greater than that of the main impulse, so that the latter is obscured until the former begins to decay.

Differences around the earth between recorded times of the first impulse, whether the sudden commencement is an SC or SC* type, are only a few seconds, and the evidence suggests that the position of the sun controls the hemisphere in which the sudden commencement first occurs. This finding is interpreted in terms of the Singer shock-wave theory to mean that, as would be expected, the shock wave enters the auroral zone nearest the sun first and produces the sudden commencement a few seconds earlier in that hemisphere. At the equinox the sudden commencement times are roughly symmetrically distributed with respect to the geomagnetic equator. --Auth.

1-1698. Bichan, W. James. CORRELATION OF AEROMAGNETIC DATA WITH SOURCE MINERALOGY: Econ. Geology, v. 54, no. 3, p. 512-15, 1959.

In 1955 and 1956, potentially commercial deposits of chrysotile asbestos were discovered in Baie Verte, Newfoundland, in an ultramafic, probably ultrabasic rock which should have registered as an anomaly in an aeromagnetic survey, but did not. Factors which may explain this are: 1) the freedom from titania, 2) a totality of martitization in the absence of titania. Perhaps where magnetite was originally present, and if martitization is incomplete, some titania is essential to the appearance of neutral areas and areas of anomalous negative intensity such as those treated by J. R. Balsley and A. F. Buddington (Econ. Geology, v. 53, no. 7). --M. Russell.

1-1699. Das, Sisir Chandra. ON THE GENERAL PLANE PROBLEM OF PLASTICITY AND ITS GEOPHYSICAL SIGNIFICANCE: Canada, Dominion Observatory, Contr., v. 3, no. 21, [12] p., 2 figs., 1959, 15 refs.; reprinted from: Can. Jour. Physics, v. 37, no. 1, p. 63-74, Jan. 1959.

The results obtained from the fault plane studies made in the Dominion Observatory show strong horizontal displacements in the focus of earthquakes. This indicates a marked deviation from the existing theories of geotectonics. To account mathematically for them, the study of the plane problem of plasticity is proposed using as yield condition a general functional relation between the stresses.

The differential equations involved in the problem are of nonlinear type. For solutions these are replaced by a different set of completely equivalent equations expressing variations along families of curves, known as characteristics, across which certain derivatives may be discontinuous under suitable boundary conditions.

Physically, the elastic-plastic (or rigid-plastic) interface is taken as a characteristic curve which is a fundamentally unknown thing, and which must be ascertained from symmetry of the problem or by proper experimentation. Investigations in this direction are now being done in connection with the International Geophysical Year. Meanwhile here we discuss the various relatively modern methods of linearization of the stress equations. Each of them essentially deals with transformations of co-ordinates, depending upon the form of the yield condition, though in every case the generalized nature is maintained. --Auth.

1-1700. Treitel, Sven. ON THE ATTENUATION OF SMALL-AMPLITUDE PLANE STRESS WAVES IN A THERMOELASTIC SOLID: Jour. Geophys. Research, v. 64, no. 6, p. 661-65, fig., June 1959, 15 refs.

All real materials have a finite thermal conductivity. This means that stress waves propagating through any

physically real solid suffer energy losses due to heat conduction. The equations of motion and of temperature for an elastic solid with a finite thermal conductivity are derived with the aid of the irreversible form of the second law of thermodynamics. Their solution for frequencies of physical interest show that the attenuation coefficient of a stress wave traveling in such a thermoelastic solid is proportional to the second power of the frequency. --Auth.

1-1701. Breck, Howard R. CONTINUOUS VELOCITY LOGGING METHOD: (In: Oklahoma Geophysical Society Symposium on Continuous Velocity Logging: Shale Shaker, v. 9, no. 9, p. 3-4, diag., logs, May 1959)

Continuous velocity logging instruments use pulsed sound waves, obtain continuous recordings of the compressional velocities in the formations logged. In a single-receiver instrument the time measured is the first arrival of the compressional wave from the transmitter through the mud, the formation, and back through the mud to the receiver. In a 2-receiver instrument the path is the same but the difference in time of arrival of the wave to the 2 receivers is measured. The 2-receiver instrument is currently preferred because of simplicity in calculation. Sample logs illustrate how various rock formations appear in the logs. --M. Russell.

1-1702. Robinson, W. B. PRESENTATION OF A VELOCITY MIS-TIE: (In: Oklahoma Geophysical Society Symposium on Continuous Velocity Logging: Shale Shaker, v. 9, no. 9, p. 7-9, 3 figs., May 1959)

An example of a continuous velocity mis-tie is the log made in Dec. 1957 of the Gulf Daisy McKinney, Section 24-2N-5W, Carter Knox field, where data in the Springer shale section are inconsistent. Factors of poor data recording include precision in depth measurement, unusually large hole diameters, and the hygroscopic effect of shale. --M. Russell.

1-1703. Nolting, Robert P. AREAS WHERE MIS-TIE OCCURS BETWEEN TWO-RECEIVER VELOCITY LOG DATA AND CHECK SHOT DATA: (In: Oklahoma Geophysical Society Symposium on Continuous Velocity Logging: Shale Shaker, v. 9, no. 9, p. 10-11, 3 maps, 2 tables, May 1959)

Three general areas tend to show shale damage type error, and selection of a proper 2-receiver tool to be used in these areas is necessary to insure correct analysis of the velocity variations. These general areas are:

1. Anadarko basin area.
2. Gulf Coast area from western Florida to southern Texas.
3. The N. and W. fringes of the central basin platform.

In author's opinion other general areas will be found to have the shale damage type error problem when more 2-receiver data is available. --Auth. concl.

1-1704. Broding, R. A. POSSIBLE CAUSES OF VELOCITY MIS-TIES: (In: Oklahoma Geophysical Society Symposium on Continuous Velocity Logging: Shale Shaker, v. 9, no. 9, p. 12-14, 6 figs, May 1959) 4 refs.

Reference shot times can be relied upon if the time ties check from 2 or more sides and the quality of the breaks is good. Any errors in a seismic reference point can be qualified from the seismogram. If good data is obtained, an accuracy considerably better than 1% should be obtained. For this reason the reference time is considered the "true time."

Integration of the sonic signal as the log is being run is inherently as accurate as the prime data, or 1%. Unfortunately, the need for time correcting integrations of the raw data from the seismic tie shots involves reintegration by tracing methods in present procedures. These reintegrations are considered to have an accuracy of + or - 1%. Therefore, the final integrated log cannot be considered better than + or - 2% if we allow a 1% error for log tracing integration means. Time integrations corrected by tie shots can be relied upon to the accuracy of the tie shot (i. e. + or - 1 millisecond).

If differences in log data are found to be in excess of 2%, the log data is considered to be in error. Intelligent appraisal of the log data with the reference check shots will generally point to possible sources of error. Such studies, combined with statistics on errors obtained from numerous surveys, are our best guide to improvement in this procedure. --Auth. summ.

1-1705. Kokesh, F. P. LIMITS OF ACCURACY OF PRESENT SONIC LOGGING EQUIPMENT: (In: Oklahoma Geophysical Society Symposium on Continuous Velocity Logging: Shale Shaker, v. 9, no. 9, p. 15-16, May 1959)

The total travel time across a section of open hole can be measured by sonic logging equipment with an error of no more than 1%. The upper limit of accuracy is probably about one-tenth of a percent. Sources of error are: 1) hole conditions, including temperature, pressure, hole profile, zones of weak signal and extreme hole size; 2) imperfect instrumentation, including sonde tilt, detection of first arrivals, time to amplitude conversion, and reliability of electronic components; and 3) the human element. --M. Russell.

1-1706. Hicks, Warren. ADJUSTMENTS OF VELOCITY LOGS TO TIE GEOPHONE SURVEYS: (In: Oklahoma Geophysical Society Symposium on Continuous Velocity Logging: Shale Shaker, v. 9, no. 9, p. 17-18, 20, 3 figs., May 1959)

Where both a geophone survey has been shot and a velocity log run for the same well, the 2 logs usually do not precisely agree, and an effort to make the 2 curves fit may be made. One method, the parallel shift method, is to add a constant time shift to one of the logs to make it confirm. Another method, the multiplier method, is to introduce a multiplicative term. Shale damage is a source of error which may cause only parts of logs to disagree. --M. Russell.

1-1707. Biggs, W. P. SONIC LOGGING IN SOUTH TEXAS: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 34-39, 9 figs., 1958, 5 refs.

The sonic log has proven itself a valuable aid to reservoir evaluation and fluid detection in S. Texas. Use of the short-spacing, 2-receiver device provides

a sharply detailed, continuous velocity log that is not affected by hole size or mud type.

Porosity resolution of the sonic log is excellent, particularly in limestone and compacted sand formations. The linear relation between porosity and the recorded interval transit time facilitates scaling and reading of the log. In the less consolidated zones, corrections are applied for lack of compaction, presence of hydrocarbons, and presence of shale.

In high porosity sands of S. Texas gas saturation has been strikingly indicated by cycle skipping. Also in these zones, a qualitative comparison of resistivity measurements and formation velocities has readily distinguished gas, oil, and water levels. --Auth.

1-1708. Hambleton, William W., ed. SYMPOSIUM ON GEOPHYSICS IN KANSAS: Kansas, State Geol. Survey, Bull. 137, 375 p., illus., maps, secs., graphs, tables, July 1959, refs.

A representative collection of 25 papers dealing with geophysics and geophysical exploration solicited from individuals, industries and government agencies known to have participated in geophysical studies in Kansas. Each of the papers is abstracted separately below in the order in which it appears in the symposium. --A. C. Sangree.

1-1709. Jewett, John M., and Daniel F. Merriam. GEOLOGIC FRAMEWORK OF KANSAS - A REVIEW FOR GEOPHYSICISTS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 9-52, 13 maps, 2 secs., July 1959) 75 refs.

In Kansas, characteristics of the rock section down to the sub-Paleozoic erosional surface are fairly well known. Rocks constituting this part of the crust are, in this paper, grouped in 6 divisions for convenience in discussion. These divisions are: Cambrian-Ordovician, Silurian-Devonian, Mississippian, Pennsylvanian-Permian, Mesozoic, and Tertiary-Quaternary rocks. The less well known Precambrian rocks, into which the sub-Paleozoic floor is cut, are included as a seventh division and are by far the greatest part of the earth's crust in Kansas.

Structure of the rocks is revealed by outcrop and subcrop patterns on erosional surfaces, including unconformities and the present land surface.

Petroliferous provinces in Kansas coincide with major post-Mississippian - pre-Des Moinesian rather than earlier structural provinces. --Auth.

1-1710. Merriam, Daniel F., and William W. Hambleton. EXPLORATION GEOPHYSICS IN KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 53-62, map, 2 graphs, table, July 1959) 60 refs.

Although much geophysical work has been conducted in Kansas in the last 3 decades, few results have been published. Information, however, is available on the number of crews, crew weeks, and county location of exploratory work, so that some conclusions can be drawn as to the relative value of the different geophysical methods in locating hidden mineral deposits. Most of the present exploratory work in Kansas is being conducted by private industry in locating petroleum reserves. Seismic techniques have proved to be the most successful of the geophysical tools.

A complete bibliography of published geophysical papers on Kansas is presented. The subjects include magnetic, gravity, electrical, and seismic work, but exclude borehole investigations and geochemical studies. -- Auth.

1-1711. Woollard, G. P. THE RELATION OF GRAVITY TO GEOLOGY IN KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 63-103, 10 maps (2 in pocket), graph, cross sec., profiles, table, July 1959) 27 refs.

An analysis of gravity anomaly variations in Kansas is presented in terms of known geologic features such as the thickness and nature of the sedimentary rocks, the configuration and composition of the crystalline basement rock complex, probable but as yet unknown lithologic variations within the basement complex as suggested by magnetic studies as well as gravity measurements, and probable variation in crustal thickness and composition. Because the basal portion of the stratigraphic column in Kansas consists chiefly of limestone whose density equals or exceeds that of the average crystalline basement rock material, the configuration of the basement rocks is for the most part effectively masked. Where there are apparent correlations with basement structure, as over the central Kansas uplift and part of the Nemaha anticline, the gravity effect must be attributed to probable mafic rocks at depth, most of which do not reach the surface of the crystalline rock floor. The mean density of the geologic column down to the -3,000-ft. level (lowest sediments) shows a progressive decrease from about 2.67 g./cc. to 2.54 g./cc. from E. to W. across the state, and this decrease seems to correlate with the regional E.-W. gravity anomaly gradient of about 65 mgal., but the geologic effect actually computes to be only about 6 mgal. The isostatic effect, on the other hand, for the change in elevation of about 3,000 ft. demands a regional gravity change of about 90 mgal. As the net observed change after correcting for the surface geology is only about 59 mgal., the change in crustal thickness seems to be considerably less than that implied by isostatic theory. This is substantiated by average negative isostatic anomalies of about 20 mgal. over the eastern part of the state. Residual gravity anomalies as well as the magnetic anomaly pattern suggest a crystalline basement mosaic embodying about 20 major and numerous minor areas of abnormality. Most of these are not known from more than 1,600 wells penetrating to basement, which suggest a much more nearly homogeneous basement although rocks ranging in composition from acidic to basic, as well as schists, gneisses, and quartzites, are present. -- Auth.

1-1712. Lyons, Paul L. THE GREENLEAF ANOMALY, A SIGNIFICANT GRAVITY FEATURE: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 105-120, 4 maps, 2 profiles, July 1959) 19 refs.

A gravity maximum anomaly, which attains a relief of almost 140 mgal., Bouguer, traverses the Salina basin of Kansas, extending southward into Oklahoma and northeastward into the Lake Superior area. It represents an ancient tectogene arc about 1,100 mi. long and is perhaps related to the Nemaha uplift to the E. It is interpreted to represent unusually dense rocks at or near the surface of the

Precambrian floor, extending the Lake Superior elements far to the S. Continued adjustment of this crustal element has contributed to basin development and structures in the overlying sediments. The anomaly implies that "iron ranges" similar to those of the Superior region may underlie areas flanking its trace in Iowa, Nebraska, Kansas, and Oklahoma. -- Auth.

1-1713. Jopling, Don W., and Kendall Cashion. REGIONAL GRAVITY OF KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 121-33, 2 maps, 3 cross secs. and profiles, July 1959) 7 refs.

This report includes a regional Bouguer gravity anomaly map of Kansas contoured on a 10-mgal. interval, 3 gravity profiles, and geologic cross sections, and a discussion of geologic structures that coincide with gravity anomalies. The data were compiled by Exploration Surveys, Inc., Dallas, Texas. With few exceptions, control for compilation of the gravity map is excellent; only in the northeastern portion of the state is the control sparse. Known or suspected major structural elements that have good regional expression are discussed in relation to gravity anomalies; discussion of local detail is omitted. -- Auth.

1-1714. King, Elizabeth R. TWO AEROMAGNETIC PROFILES ACROSS WESTERN KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 135-41, 2 profiles, July 1959) 5 refs.

Two aeromagnetic profiles were flown, one westward from Salina and one across the SW. corner of Kansas, by the U. S. Geological Survey in 1950-1951. The magnetic pattern consists of a series of large anomalies modified by several minor features, superposed on a slight positive regional gradient to the E. Depth analyses of several broad anomalies indicate that they originate deep within the Precambrian complex, and several of the smaller features may be caused by variations in magnetic susceptibility extending downward from the top of the Precambrian rocks. --Auth.

1-1715. Agocs, W. B. COMPARISON OF BASEMENT DEPTHS FROM AEROMAGNETICS AND WELLS ALONG THE NORTHERN BORDER OF KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 143-52, 5 figs. incl. 3 illus., July 1959) 7 refs.

The aeromagnetic data obtained along the N. border of Kansas by Aero Service Corporation in 1948 have been analyzed to determine the depth and structure of the Precambrian basement rocks and to compare these data with depths and structure obtained from wells and with Bouguer gravity anomaly data.

The depth to the basement obtained from aeromagnetics is in good general agreement with the well depths, considering that the magnetic control from only a single profile was used. There is little or no correlation between Bouguer gravity anomaly and aeromagnetics or basement structure, probably owing to wide separation of gravity stations and the fact that the source of the gravity anomalies may be attributed to the sedimentary rocks. --Auth.

1-1716. Merriam, Daniel F., and William W. Hambleton. RELATION OF MAGNETIC AND AEROMAGNETIC PROFILES TO GEOLOGY IN KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 153-73, 8 figs. incl. map, cross secs., profiles, July 1959) 18 refs.

Seven E.-W. magnetic and aeromagnetic profiles in eastern and northern Kansas are presented, accompanied by geologic cross sections for comparison. Two profiles are regional, extending across the state from Missouri to Colorado; 5 of the profiles are shorter. They cross several major post-Mississippian structural provinces, including the Forest City basin, Cherokee basin, Salina basin, Hugoton embayment, Nemaha anticline, Cambridge arch, and central Kansas uplift.

Seemingly there is no connection between magnetic anomalies and configuration of the Precambrian basement complex, except in northwestern Kansas where the Cambridge arch is reflected as a magnetic high and in southeastern Kansas where magnetic lows locally reflect structural highs. Thinning of sedimentary rocks, especially beds of Mesozoic and Permo-Pennsylvanian age, seemingly causes a rise in the magnetic gradient. Most magnetic anomalies in Kansas may be due to lithologic changes in the Precambrian basement complex. --Auth.

1-1717. Agocs, W. B. AIRBORNE MAGNETOMETER PROFILES, MORRIS AND WABAUNSEE COUNTIES, KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 175-80, 2 figs., July 1959) 2 refs.

Two 30-mi. long E.-W. airborne-magnetometer profiles separated by a distance of 9 mi. were flown in the northern part of Morris and Wabaunsee counties across the Nemaha ridge; they were closed by 2 N.-S. airborne-magnetometer profiles.

Although the profiles could not be analyzed quantitatively, the magnetic data show a marked susceptibility contrast on the western approach to the Nemaha ridge. These data agree with magnetic data along the N. border of Kansas and also with a Bouguer gravity profile, which shows a marked discontinuity or level change on the approach to the Nemaha ridge, and probably indicate that the basement W. of the Nemaha ridge consists of mafic igneous rock and the Nemaha ridge of granite. --Auth.

1-1718. Wantland, Dart. GEOPHYSICAL INVESTIGATIONS ON PROJECTS OF THE UNITED STATES BUREAU OF RECLAMATION IN KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 181-97, 6 figs. incl. 2 maps, July 1959) ref.

Results of geophysical investigations by the U. S. Bureau of Reclamation in Kansas over a period of 16 years are summarized. Refraction seismograph and electrical-resistivity methods were used to study possible dam sites and to determine quantity of materials available for construction purposes. Reconnaissance refraction surveys to determine bedrock depth at Elkader, Elkader Alternate, and Pyramid dam sites on Smoky Hill River in Gove and Logan counties indicated, based on bedrock depth only, that Elkader was the most desirable site because bedrock was at minimum depth. Resistivity investigations at the Herndon and Ludell quarry sites in Rawlins County were made to locate zones of opaline-cemented material in the Ogallala formation for use as riprap. Because these zones had a

higher resistivity than surrounding material, it was possible to supplement drillhole information for yardage computations. Similar investigations were made at a quarry in Ness County near Cedar Bluff dam site. Estimates of available material were in close agreement with independent estimates made by engineers. Seismic refraction studies at Cedar Bluff dam site on Smoky Hill River in Trego County located and traced a known buried stream channel and showed that it did not have an outlet along the toe of the dam and thus could not provide a leakage path for water in the reservoir. A similar investigation at the site of Kirwin dam in Phillips County on North Fork Solomon River was used to outline and trace the course of 2 buried channels that cut the axis of the proposed dam. Reconnaissance refraction seismograph studies were made at the site of the proposed Glen Elder dam on North Fork Solomon River in Mitchell County to supply subsurface information for selection of the best site. Depth determinations were in close agreement with drillhole depths used as control points. --Auth.

1-1719. Crumpton, Carl F., and W. A. Badgley. UTILIZATION OF EARTH-RESISTIVITY MEASUREMENTS BY THE STATE HIGHWAY COMMISSION OF KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 199-207, 3 figs., July 1959) 7 refs.

An earth-resistivity instrument has been used to supplement information, gained by other methods, concerning engineering geology and its application to the design and construction of highways in Kansas. This instrument has been successfully used in the preliminary classification of excavation, the location of low-displacement faults, and in the evaluation of quarry sites for the type and extent of materials present. It has also been used with success in indicating the presence of vertical joints in limestone quarries. --Auth.

1-1720. O'Connor, Ralph E., and Charles K. Bayne. ELECTRICAL RESISTIVITY STUDIES IN BRINE POLLUTION PROBLEMS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 209-18, 8 figs. incl. 2 maps, table, July 1959) 3 refs.

Electrical resistivity equipment was field tested to determine its feasibility as a reliable and rapid means of tracing subsurface brine concentrations in connection with pollution abatement studies of the Oil Field Section, Division of Sanitation, Kansas State Board of Health. A successful study was completed NE. of Chase in Rice County. A study at Iuka, in Pratt County, was not successful because pipelines, casing, and other unknown materials acted as shunts or otherwise disturbed the current pattern and caused anomalies that were not separable from anomalies due to brine concentrations. Resistivity surveys have been unusually reliable in determining the configuration of brine concentrations where control data are available to correct interpretations for extraneous anomalies. Absence of control data is the primary reason for the erroneous interpretation at Iuka. --Auth.

1-1721. Hartenberger, R. A. A RADIOACTIVITY SURVEY OVER ROSE DOME, WOODSON COUNTY, KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 219-24, 3 figs., July 1959) 7 refs.

A radioactivity survey was made over Rose dome, Woodson County, Kansas, to determine whether intrusive granite rocks would produce a radioactive anomaly. Two traverses indicate the presence of the granite on the dome. -- Auth.

1-1722. Glover, Robert H. TECHNIQUES USED IN INTERPRETING SEISMIC DATA IN KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 225-40, 6 figs., table, July 1959) 8 refs.

Many of the structures of Kansas are small and of low relief. The unknown quantities assumed in conventional seismic computation may result in errors of such magnitude that they completely mask oil field structures or relative dip adjacent to points of geologic control. Improvement in recording techniques and interpretation has decreased this error greatly. Knowledge, gained only by experience with many problems, makes the seismologist aware of the cause of error. This paper lists many of the problems and suggests new methods of solving them. -- Auth.

1-1723. Kulstad, Robert O. THICKNESS AND SALT PERCENTAGE OF THE HUTCHINSON SALT: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 241-47, fig., map in pocket, July 1959) 7 refs.

This paper includes a thickness and salt-percentage map of the Hutchinson salt member of the Wellington formation (Permian). Isopachous lines are on a 50-ft. contour interval; salt percentage is shown on a 20% interval. The various kinds of well logs that served as sources of data for compilation of the map are discussed and compared. --Auth.

1-1724. Beebe, B. W. A CASE HISTORY OF THE KOELSCH SOUTHEAST POOL, STAFFORD COUNTY, KANSAS; A STUDY IN MICROSEISMICS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 249-74, 14 figs. incl. 12 maps, July 1959) 3 refs.

The Koelsch Southeast field, sec. 25 and 36, T. 24 S., R. 14 W., Stafford County, Kansas, is one of many small oil fields in the area that produce from the Arbuckle dolomite. Accumulation of oil is the result of a small structural closure on the Arbuckle with approximately 40 ft. of relief. The local anomaly is superimposed on the axis of a regional southwestward-plunging anticline. Conventional seismic work had failed to locate the oil field. Three dry holes had been drilled in proximity to the field before its discovery. A seismic survey, using a somewhat unusual technique of interpretation and careful precise field procedure, outlined the anomaly on which production was found. A very close comparison can be made between seismic and subsurface data. The history of the discovery and development of the field is a classic example of the benefits to be derived from a carefully planned, well conceived exploration

program based on unusually close cooperation and understanding between geologists and geophysicists. The methods used have wide application where comparable circumstances and conditions are anticipated. -- Auth.

1-1725. Brewer, John E. GEOPHYSICAL PROBLEMS ON PRATT ANTICLINE, PRATT COUNTY, KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 275-80, 4 maps, July 1959)

Geophysical work in Pratt County, Kansas, is characterized by many unique problems. These problems include selection of a suitable reference plane marker for isotime mapping, correct correlation of reflections in places where section thickening produces additional reflections, and correct correlation of reflections in areas of complex faulting and truncation. Methods of solving these problems are outlined. --Auth.

1-1726. Care, John L., Lee Brooks, and Charles H. Wallace. GEOPHYSICAL CASE HISTORY OF THE ENGEL POOL: (In: Hambleton, William H., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 281-86, 4 figs. incl. 3 maps, July 1959)

This paper presents a case history of the Engel pool [Antonino, Kansas] and outlines the advantages of the seismic method on the central Kansas uplift. A dense control pattern was used, based on the spot-correlation method. Isotime maps between the Stone Corral anhydrite and an upper Pennsylvanian reflection and between the anhydrite and the Ordovician-Pennsylvanian unconformity show a small anomaly on which the discovery well was drilled. -- Auth.

1-1727. Brewer, Ralph R., Jr. A GEOPHYSICAL CASE HISTORY OF THE LINDSBORG POOL, McPHERSON COUNTY, KANSAS: (In: Hambleton. William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 287-95, 5 figs. incl. 3 maps, July 1959) ref.

A brief history is presented of the exploration procedure used in the discovery of the Lindsborg pool, McPherson County, Kansas, with a description of the seismic equipment and methods used to discover the anomaly. The significance of the discovery is discussed briefly. -- Auth.

1-1728. Rupnik, John J. CASE HISTORY OF THE DUNES POOL, PAWNEE COUNTY, KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 297-308, 7 maps, July 1959) ref.

The Dunes pool was one of several pools discovered in central western Kansas as a result of a program of coordinated subsurface and seismic exploration. This paper discusses the procedure used in evaluating the area, and several maps are presented as illustrations. -- Auth.

1-1729. Smith, M. W. HISTORY OF THE WINDOM POOL, McPHERSON AND RICE COUNTIES, KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 309-320, 9 maps, July 1959)

This paper presents a history of the events leading to development of the Windom pool, a geological and geophysical discovery in western McPherson County and eastern Rice County, Kansas. Windom was not highly regarded as a prospective producing area, because it was thought to be down dip from the Welch-Bornholdt pool, which is a stratigraphic trap. Widely spaced core holes in shallow Permian beds revealed only structural flattening, but preliminary subsurface mapping based on drillers logs from 4 widely spaced wells suggested an anticlinal structure. The structural feature was localized by a series of continuous seismic profiles, which shifted the top of the structure southward from its mapped location. A subsequent seismic program successfully obtained good reflections from Pennsylvanian rocks below the Lansing, from within the Mississippian, and from near the top of the Arbuckle, and tied with well control. The discovery well, which was located on top of the structure shown by the Lansing map, produced from basal Pennsylvanian chert conglomerate and from Mississippian rocks.

Since discovery, the pool has been mapped in detail by seismograph, and there has been close correlation of drilling and seismic programs. The success of the procedure is demonstrated by a record of 27 producing wells as compared to 4 dry holes. Production also has been found on the flanks of the structure, where the Pennsylvanian chert conglomerate is thicker than on top of the structure. Illustrations include seismic reflection and structural maps. --Auth.

1-1730. Bass, B. L., and L. H. Lukert. GEOPHYSICAL HISTORY OF THE FALL CREEK POOL, SUMNER COUNTY, KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 321-33, 12 figs. incl. 9 maps, July 1959) ref.

The Fall Creek pool, underlying parts of sec. 3, 4, 9, and 10, T. 35 S., R. 3 W., Sumner County, Kansas, was discovered on Aug. 31, 1950, by The Texas Company No. 1 Hobbisiefkin well, which had calculated potential of 6,226 barrels of oil per day from the upper part of the Simpson group. A seismic survey in 1949 and 1950 located the prospect and the original drilling site.

Seismic maps, prepared prior to drilling, and subsurface maps made from information derived from subsequent drilling show that the Fall Creek pool lies on a simple, slightly elongate, SW.-trending anticline. Dips on the N. and E. are steep, and there is a westward shift of the apex of the anticline at the top of the Marmaton as related to Viola structure. An accentuation of structural closure with depth is also discernible. The pool produced 2,055,851 barrels of oil prior to Sept. 1, 1957. --Auth.

1-1731. Winchell, Richard L. LAW SOUTHEAST POOL - A SUCCESSFUL SEISMIC DISCOVERY IN GRAHAM COUNTY, KANSAS: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 335-49, 12 figs. incl. 10 maps, July 1959) 3 refs.

The Law Southeast pool was discovered in Jan. 1955, as a result of a program of seismic exploration. Prior

to the seismic survey, 3 dry holes, which gave no indication of local structure, had been drilled in the area. This paper compares seismic interpretation before drilling with geologic interpretation after drilling, to show successful results of seismic exploration. -- Auth.

1-1732. Koester, Edward A. A SUCCESSFUL SEISMIC PROGRAM ON THE CENTRAL KANSAS UPLIFT: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 351-55, 2 maps, July 1959) 2 refs.

This paper describes a successful geophysical exploration program on the central Kansas uplift in Ellis, Rooks, Trego, and Rush counties that resulted in the discovery of 14 pools. -- Auth.

1-1733. Hambleton, William W., Joseph P. Lyden, and Douglas C. Brockie. GEOPHYSICAL INVESTIGATIONS IN THE TRI-STATE ZINC AND LEAD MINING DISTRICT: (In: Hambleton, William W., ed. Symposium on Geophysics in Kansas: Kansas, State Geol. Survey, Bull. 137, p. 357-75, 4 maps, 2 secs., July 1959) 14 refs.

This paper reviews geophysical exploration for zinc and lead sulfide ore bodies in the Tri-State mining district of Kansas, Oklahoma, and Missouri. The results of magnetic, gravity, electrical, radio, geochemical, and seismic surveys are summarized. Particular attention is given to refraction seismograph work in Cherokee County, Kansas, conducted in 1955 but previously unreported in the literature. -- Auth.

7. GEOCHEMISTRY

See also: Mineralogy 1-1753; Igneous and Metamorphic Petrology 1-1762; Geohydrology 1-1776; Mineral Deposits 1-1779, 1-1784, 1-1800, 1-1801, 1-1802; Fuels 1-1812.

1-1734. Kullerud, G., and Hatten S. Yoder. PYRITE STABILITY RELATIONS IN THE Fe-S SYSTEM: Econ. Geology, v. 54, no. 4, p. 533-72, 12 figs., 13 tables, June-July 1959, 103 refs.

The reaction pyrite $\rightleftharpoons$ pyrrhotite + liquid (or gas) was investigated up to 5,000 bars by means of a new technique. The univariant equilibrium curve for the reaction originates at an invariant point 743° C. and about 10 bars and passes through the points 748° C., 335 bars; 755°, 1,000 bars; 770°, 2,000 bars; and 810°, 5,000 bars.

The relations of pyrite in the Fe-S system are deduced from thermodynamic principles and available data. The limitations of the various experimental techniques for sulfide systems are analyzed in the light of the pressure-temperature diagram for the Fe-S system. The apparently large effect of Fe in the vapor or gas of the system is described.

The occurrence of primary pyrite in some gabbros, amphibolites, and granites and not in basalts and rhyolites is accounted for by comparing the upper stability curves of pyrite at various partial pressures of S with the beginning of melting curves of rocks of basaltic and granitic compositions under hydrous conditions. When the partial pressure of S is less than about 10 bars small changes in its value have a great effect on the stability of pyrite. The relations of pyrite in the Fe-S system indicate that massive pyrite bodies could not have crystallized directly from a liquid of pyrite composition. --Auth.

1-1735. Strong, Herbert M. THE EXPERIMENTAL FUSION CURVE OF IRON TO 96,000 ATMOSPHERES: Jour. Geophys. Research, v. 64, no. 6, p. 653-59, 7 figs., June 1959, 32 refs.

The melting point of Fe has been determined to 96,000 atmospheres, and the temperature for the $\alpha - \gamma$ transition to 76,000 atmospheres. Simon's fusion equation, $P/a = (T/T_o)^c - 1$, fits the experimental melting points with a = 75,000 atm. and c = 8. Extrapolation of the melting points to 1.4×10^6 atm., the pressure at the boundary of the earth's core, gives 2340 + 200°C. The temperature for the $\alpha - \gamma$ transition decreased about 200°C. at 76,000 atm. --Auth.

1-1736. Hawley, J. E., and Ian Nichol. SELENIUM IN SOME CANADIAN SULFIDES: Econ. Geology, v. 54, no. 4, p. 608-628, 2 figs., 10 tables, June-July 1959, 23 refs.

Determinations of Se contents have been made by X-ray spectrographic means on pyrite, pyrrhotite, pentlandite, and chalcopyrite from a variety of Canadian ores including a high-intensity magnetite replacement body, several nickeliferous copper sulfide (magmatic) ores of Sudbury, 9 massive, nonnickeliferous, Cu, Fe, (Zn) hydrothermal replacement ores chiefly from Quebec and Ontario, 10 pyritic gold-quartz deposits, banded siderite-pyrite (chert) deposits, Michipicoten, and pyritic, uraniferous ores of Algoma, Ontario.

Richest Se concentrations are found in some of the Precambrian nonnickeliferous Cu ores, containing several hundred to 1,000 p. p. m. Se, but even in these, relatively Se-rich and Se-poor provinces are evident. One Precambrian and 2 Paleozoic Cu ores are of the latter type. The Sudbury deposits are intermediate between the 2 extremes, Se in these averaging between 50 and 100 p. p. m. in the 4 common sulfides. Pyrites in gold-quartz ores, in the banded Michipicoten deposits, and in the U ores of Algoma average less than 50 p. p. m. Se but range to below the limit of detectability (15 p. p. m.).

In general no order of preference is indicated by the individual sulfides but in several Cu ores and also in the Sudbury ores the tendency is noted for the progressive concentration of Se with the order of crystallization and in some, amounts of pyrrhotite and chalcopyrite are fairly similar. It is suggested that the apparent lack of order in other deposits may be due to contamination of earlier sulfides in a restricted system by late vapors or Cu-rich fluids penetrating earlier minerals.

Variations in Se with apparent temperature of formation of pyrite in a Au ore, and vertical and horizontal variations in pyrite and pyrrhotite in several of the different types of deposits are noted in addition to distance from intrusives of diabase and quartz porphyry. Se is somewhat enriched in lower temperature pyrite, a distinct enrichment is noted in the upper levels of more deeply explored deposits, McIntyre and Noranda, and variations in others occur over shorter distances. Horizontal variations with respect to intrusives are irregular to negligible in some cases, but are more regular in others, Se being highest at about 100 ft. from

quartz porphyries (McIntyre) and near the contact of larger diabase dikes (Noranda and Geco). Very extensive sampling of all deposits is required before a clear picture can be obtained of the distribution of Se in a single ore deposit.

The low to negligible Se content of gold-quartz deposits is attributed to Se-poor magmatic sources and/or wall rocks. In marked contrast to the Se-rich U ores of the Colorado plateau are the low-Se siderite ores of Michipicoten, also associated with tuffs, and the (non-tuffaceous) Algoma U ores in conglomerates, for the pyrite of which a hydrothermal rather than purely sedimentary origin is favored. --Auth.

1-1737. Voskresenskaya, N. T., and I. S. Karpova. THALLIUM IN ORE MINERALS OF THE VERKHNYAYA KVAISA: Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 552-59, 2 figs., 4 tables, 9 refs.

The Tl abundance in the chief ore minerals of the Verkhnyaya Kvaisa [Caucasus] - galena, sphalerite and marcasite - has been studied. The colloform marcasite and sphalerite are relatively enriched in Tl ores; the coarsely crystalline galena is impoverished in it. This may be explained by the peculiarity of ore deposition from colloid solutions. In the process of recrystallization of the gels of galena, the latter may to some extent purify itself from captured impurities. Probably such self-purification accounts for the appearance of a Tl mineral - hutchinsonite. A correlation of Tl and As in galena and an antipathetic behavior of As and Sb in case of a compensation replacement of Pb by Tl is noted. --Auth.

1-1738. Zlobin, B. I. GEOCHEMISTRY OF THALLIUM IN ALKALIC ROCKS, WITH MT. SANDYK MASSIF (NORTHERN KIRGIZIYA) AS AN EXAMPLE: Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 560-73, graph, 4 tables, 16 refs.

The distribution of Tl in various alkalic rocks of the Sandyk massif (monzonites, alkali earth syenites, alkalic and nepheline syenites) and its bond to K have been studied. The average value of the K/Tl ratio for the massif is 3.63×10^4. The petrogenetic signification of deviations from this value in the case of vein rocks is shown. It has been found that all the Tl of the rock is distributed among orthoclase and biotite; the preferred Tl accumulation in biotites is explained from crystal chemical viewpoints. The very close dependence of the Tl behavior on that of K is determined during the process of rock crystallization itself. In the general evolutionary process of the alkalic magma, leading to the formation of successive differentiates, this dependence shows a number of deviations. --Auth.

1-1739. Vinogradov, A. P., E. E. Vainshtein, and L. L. Pavlenko. TUNGSTEN AND MOLYBDENUM IN IGNEOUS ROCKS (AS RELATED TO THE GEOCHEMISTRY OF TUNGSTEN): Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 497-509, 2 figs., 7 tables, 23 refs.

A systematic investigation of the W and Mo content in various rocks has been carried out with the aid of a spectrochemical graphic method of analysis worked out by the authors. The average content in ultramafic rocks is: W 7.7×10^{-5}; Mo 2.3×10^{-5}%; Mo/W = 0.3; in mafic rocks: W 8.5×10^{-5}; Mo 2.2×10^{-4}; in intermediate rocks: W 1.96×10^{-4}; Mo 1.06×10^{-4}%; Mo/W = 0.55; and in felsic rocks: W 2.43×10^{-4}% and Mo 1.6×10^{-4}%; Wo/W = 0.66. It has been shown that the average Mo and W contents in rocks increase parallel with the increase of SiO_2. --Auth.

1-1740. Semenov, Ye. I. RELATIONSHIP BETWEEN COMPOSITION OF RARE EARTHS AND COMPOSITION AND STRUCTURES OF MINERALS: Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 574-86, graph, diag., 9 refs.

It has been shown that, according to the isomorphism capacity, complex and selective rare-earth minerals (Ce, Gd, and Y minerals) are isolated. The selectivity degree of minerals is determined according to the amplitude of composition change of rare earths and of their ionic radius. In minerals not of the rare-earth group the composition of rare earths is determined by their closeness of the ionic radius to the element being replaced. Thus, the minerals of Sr, Ba, K are usually selective ceric; minerals of Zr, Sc, Fe - selective yttric; of Ca - complex minerals.

The composition of rare earths may serve for diagnostic purposes and for identification of selective minerals. In selective minerals the composition of rare earths is determined according to the crystallochemical structure of minerals which limit the isomorphism capacity, in complex minerals - according to the medium, to the composition of rare earths in the initial melt or solution. --Auth.

1-1741. Ivanov, V. V. THE FUNDAMENTAL STAGES OF HYDROTHERMAL ACTIVITY OF KAMCHATKA AND KURILE ISLANDS VOLCANOES AND THE ASSOCIATED TYPES OF THERMAL WATERS: Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 600-614, 7 tables, 19 refs.

The division of volcanic gases into 2 chief groups - the "fumarolic" gases and the "solfataric" gases is to a great extent conditioned by their interaction with underground waters. In the ranges of the volcanic zone of the Kuril islands-Kamchatka, 4 stages of hydrothermal action of volcanoes and 3 chief genetic types of thermal waters are distinguished - acid sulfate, acid sulfate-chloride and alkaline chloride waters - the composition of which is shown in the tables. --Auth.

1-1742. Dorfman, M. D. GEOCHEMICAL CHARACTERISTICS OF WEATHERING PROCESSES IN NEPHELINE SYENITES OF KHIBINA TUNDRA: Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 537-51, 4 figs. incl. illus., 13 refs.

The geochemical nature of the chemical weathering processes in the Khibina alkalic massif [Kola peninsula; 67°42'N. 33°-33°14'E.], where these processes are widely displayed and related to tectonic fracture zones, is given in this article in a new light. On the basis of the geological position of the fracture zones, the mineralogical composition and the experimental investigations of the solubility of the chief alkalic rock minerals, the author distinguishes 2 geochemical types of linear weathering crusts - in steep and in gently sloping zones. In

spite of their similar age the geochemical peculiarities of the mineral-forming process are different in each of them. They are determined according to the ability of nepheline to hydrolyze easily in water, to the rate of surface water drainage, and to the difference in pH of the solutions. In steep zones where the rate of water flow will be relatively high, the pH of the medium will be the lowest. In gently sloping zones, where waters may be almost stagnant, the pH can reach 11. These differences bring about in every type of the linear weathering crust, a typical minerals association. --Auth.

1-1743. Lovering, T. S. SIGNIFICANCE OF ACCUMULATOR PLANTS IN ROCK WEATHERING: Geol. Soc. America, Bull., v. 70, no. 6, p. 781-800, fig., 9 tables, June 1959, 58 refs.; abstracts in English, French, German, and Russian.

Accumulator plants differ widely in the elements accumulated but have been studied chiefly for their capacity to pick up minor elements deleterious to agriculture. However, the ability of some plants to accumulate certain major elements, such as Si, Al, Ca, Mn, and Fe has geologic implications. Many kinds of vegetation, especially in the tropics, contain several percent silica dry weight. Some 10 to 20 tons dry weight of new growth per acre is added each year above ground in tropical jungles, and the roots add several tons more. A forest of silica-accumulator plants averaging 2.5% silica and 16 tons dry weight new growth per year would extract about 2,000 tons of silica per acre in 5,000 years - equivalent to the silica in 1 acre-ft. of basalt. Comparison of lateritic soils with parent rock indicates that a silica-accumulator jungle could convert basalt into lateritic soil rapidly - geologically speaking. The silica in ground water increases with depth and time in contact with the rock, but vadose water seems inadequate to yield the silica required by such a jungle of silica-accumulator plants; biochemical factors must therefore cause much more rapid solution of silica. Under favorable conditions, much soluble organically derived silica may be recycled or added to ground water, but nevertheless, in tropical regions with high rainfall and appreciable runoff, large amounts of siliceous organic debris must be swept off the forest floor into the drainage system. On the other hand, if insoluble silicic phytoliths result from the disintegration of the vegetal litter, the upper soil horizons may become enriched in silica from disintegrating silica-accumulator plants, where erosion does not equal the rate of accumulation, as in many prairie and savannah soils. Plants that accumulate other elements, such as Ca, Al, Mn, or Fe, may have geologic importance in developing other special soil types and in expediting the selective removal of certain elements. --Auth.

1-1744. Ronov, A. B. ORGANIC CARBON IN SEDIMENTARY ROCKS (IN RELATION TO THE PRESENCE OF PETROLEUM): Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 510-36, 11 figs. incl. 4 maps, 3 tables, 35 refs.

The author has studied the distribution of organic carbon (C_{org}) in 26,000 samples of rocks of different lithological composition and of different age and genesis, representing various facies and tectonic zones of the Russian platform, both in oil basins and in provinces devoid of oil. Statistical treatment of these data has shown that in the distribution of C_{org}, according to the stratigraphic scale, an alternation of epochs of intensive and of insignificant accumulation of organic matter can be observed. All the deposits of caustobiolites (coals, petroliferous shales, and oils) are closely tied to stratigraphic intervals with an increased content of scattered C_{org}. Comparison of data on the Russian platform with those of P. D. Trask and H. W. Patnode for the U. S. A. establishes a similar character of alternation of periods of enrichment and impoverishment of scattered C_{org} in sedimentary strata. The average C_{org} content in rocks of oil basins is three times as high as in rocks of areas not bearing oil. In the oil basins the maximum C_{org} content is observed in sediments of marine nearshore deposits, representing epineritic environments; the minimum content - in sediments of continental and lagoonal environments; and intermediate values - in sediments of open sea facies, representing infraneritic and bathyal environments. Among the marine epineritic sediments of oil basins (1.77%) and of provinces not bearing oil (0.32%) clays are richest in C_{org}. The C_{org} distribution in various rock types of continental and lagoonal facies and of open sea facies is shown. With the aid of quantitative litho-geochemical maps the C_{org} distribution in clayey carbonate and sandy upper Devonian beds of the Frasnian stage of the Russian platform has shown that in approaching the Volga-Ural oil basin the C_{org} content of the rocks increases, reaching its maximum value within the boundaries of the basin. This is seen most distinctly on the map for clay beds. A comparison with the map showing the change in the Fe_2O_3/FeO ratio in clays of the same age shows [that] parallel with the increase of C_{org} a successive increase in reducing conditions is observed, which becomes predominant in rocks of the oil basins. This indicates that the heightened C_{org} content created a regionally stable reducing medium in clayey sediments. On the one hand this has determined the transformation trend of the bitumen part of organic matter into oil, and on the other hand the changes of valence of Fe in the clays. --Auth.

1-1745. Brown, John S., and J. Laurence Kulp. LEAD ISOTOPES FROM BALMAT AREA, NEW YORK: Econ. Geology, v. 54, no. 1, p. 137-39, table, Jan.-Feb. 1959, 5 refs.

Pb isotope determinations of Pb minerals from the Balmat area, NW. Adirondacks, New York, give an age of 1050 + 100 million years. It confirms earlier conclusions that metallic mineralization in the Shield commonly follows closely after the regional metamorphism. --M. Russell.

1-1746. Baranov, V. I., Yu. A. Surkov, and V. D. Vilenskiy. ISOTOPIC SHIFTS IN NATURAL URANIUM COMPOUNDS: Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 591-99, 3 figs, incl. illus., diag., 6 refs.

Isotopic shifts in natural U compounds have been studied according to U^{234}/U^{238} ratio in a leaching solution and residue for various fractions. The determination of the U isotopic composition has been carried out on a 50-channel apparatus for α-spectra measurements. The accuracy of the determination of the U^{234}/U^{238} ratio is $\pm$1-2%. The preparation of U samples for α-spectrometric studies is described. It has been shown that U isotopic composition in natural materials can change as a result of secondary processes. By means of the described method for determining U isotopic composition the study of the U origin in various natural materials is possible. --Auth.

1-1747. Starik, I. E., F. E. Starik, and B. A. Mikhailov. SHIFTS OF ISOTOPIC RATIOS IN NATURAL MATERIALS: Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 587-90, 2 tables, 11 refs.

A modification of the method for the determination of UI and UII has been worked out, and a shift of the isotopic U composition in laboratory conditions has been obtained. --Auth.

1-1748. Bartels, Otto G. THE NAIRNE PYRITIC FORMATION, AUSTRALIA: Econ. Geology, v. 54, no. 3, p. 509-510, 1959, 4 refs.

The 500° C. pyrrhotite-sphalerite geologic thermometer result is to be preferred over B. J. Skinner's preference of 275° C. pyrite-pyrrhotite temperature in the Nairne Pyrite formation article (Econ. Geology, v. 53, no. 5, p. 546-62). --M. Russell.

1-1749. Lapham, Davis M. A TEMPERATURE INDICATOR FOR THE ORIGIN OF CHROMITE: Pennsylvania Acad. Sci., Proc., v. 32, p. 163-67, 1958, 9 refs.

Chromite occurs in 2 tectonic environments: in situ differentiates within layered plutons, and ultramafic intrusives in folded tectonic belts of the alpine type. While textures are of some use in determining chromite grade and origin, they are often unreliable. The mineralization associated with chromite is an indication of the origin of the chromite and any subsequent alteration. These factors in turn bear upon chromite grade. It is suggested that the position of Cr substitution in the Cr-chlorite lattice is a function of temperature and water pressure and, because of its close association with chromite, is indicative of the history of chromite crystallization. The influence of various ions substituting in the chromite lattice during differentiation is briefly summarized. --Auth.

8. MINERALOGY AND CRYSTALLOGRAPHY

See also: Structural Geology 1-1636; Geochemistry 1-1740; Igneous and Metamorphic Petrology 1-1757; Mineral Deposits 1-1791 through 1-1796.

1-1750. Kerr, Paul F. OPTICAL MINERALOGY: 3d ed., 442 p., 415 figs. incl. illus., charts, diags., graphs, 7 tables, New York, McGraw-Hill Book Company, Inc., 1959, refs.

The first objective of this revised edition (previous editions prepared by Austin F. Rogers and Paul F. Kerr) has been the preparation of a text which can be used with a minimum of supervision. The format of mineral description has been retained, and the length of the text is essentially the same. Each mineral description has been reviewed, many revised, and a few added. New illustrations show improved equipment now available. The text is intended primarily for thin-section study, but will also be useful for work with mineral fragments. The feldspars have been considerably revised, other mineral groups somewhat less extensively.

The text is in 2 parts. Part 1. Mineral Optics, deals with the following subjects: mineral preparations for microscopic study; the polarizing microscope, properties of light; refraction; plane polarized light in minerals; convergent polarized light; the universal stage; color, mode of aggregation, cleavage, and orientation; mineral fragments; systematic identification.

Part 2. Mineral Descriptions, deals in turn with the mineral groups: elements to hydroxides; carbonates, sulfates, and phosphates; silicates: framework structures; silicates: chain structures; silicates: single, multiple, and ring SiO_4 structures; silicates: sheet structures and mineraloids. --A. C. Sangree.

1-1751. Brown, John S. OCCURRENCE OF JORDANITE AT BALMAT, NEW YORK: Econ. Geology, v. 54, no. 1, p. 136-37, Jan.-Feb. 1959.

Jordanite (a sulpharsenite of Pb) was discovered in 1930 in the Balmat Pb mine, New York, and identified as such in 1939. A minor accessory mineral may be tennantite. --M. Russell.

1-1752. Flinter, B. H. THE ALTERATION OF MALAYAN ILMENITE GRAINS AND THE QUESTION OF "ARIZONITE": Econ. Geology, v. 54, no. 4, p. 720-29, 4 illus., 4 tables, June-July 1959, 6 refs.

Examination of ilmenite grains occurring in the alluvium of Malaya confirms the work of various authors in that this mineral undergoes weathering processes that result in a standard progression of alteration from pure ilmenite to a mixture of rutile and hematite (or any related titanium and iron oxide minerals).

A correlation is made of the effects of this alteration on the chemical, physical, and optical properties of the mineral. In the Malayan material 2 distinctly recognizable phases are present. In the first phase the ilmenite has undergone little, if any, alteration. In the second phase the ilmenite structure has broken down and the material is amorphous. This phase is recognized by a marked decrease in mass magnetic susceptibility, an increase in TiO_2 and H_2O content, and a high Fe^3/Fe^2 ratio. These changes bear directly upon the mineral's extraction properties and so there is a strong economic reason for distinguishing it from the first phase. It is proposed that the term "hydroilmenite" (after Blomstrand) should be given to this phase and that the term "arizonite" should be retained to indicate the final phase of alteration in which the material has recrystallized into a mixture of titanium and iron oxide minerals. --Auth.

1-1753. Basta, E. Z. SOME MINERALOGICAL RELATIONSHIPS IN THE SYSTEM Fe_2O_3-Fe_3O_4 AND THE COMPOSITION OF TITANOMAGHEMITE: Econ. Geology, v. 54, no. 4, p. 698-719, 4 figs. incl. 3 illus., 5 tables, June-July 1959, 47 refs.

Chemical, mineragraphic and X-ray investigations are carried out on minerals belonging to the system Fe_2O_3-Fe_3O_4. The existence of minerals intermediate in composition between magnetite and maghemite is proved with certainty, and a brief discussion is given on the oxidation of natural magnetite. Similar data are presented on titanomaghemites and an attempt is made to explain the great variations in their chemical composition. It is suggested that titanomaghemites are formed mainly by the oxidation of titanomagnetite Fe_3O_4- γ -$FeTiO_3$ and that they represent a series varying in composition from γ-Fe_2O_3. Fe_3O_4 - γ -$FeTiO_3$ to γ-Fe_2O_3-TiO_2. --Auth.

1-1754. Ginzburg, A. I., S. A. Gorzhevskaya, E. A. Erofeeva, and G. A. Sidorenko. THE CHEMICAL COMPOSITION OF ISOMETRIC TITANIUM-TANTALUM NIOBATES: Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 615-36, 9 figs. incl. 4 diags., 3 tables, 21 refs.

The empirical formulas of minerals differ markedly from the theoretical formulas universally adopted for them. A deficiency of cations in the "A" group has been ascertained. In connection with this formula $A_{n-x}\ B_p\ X_q$ is proposed, where x is the value determining the deficiency in the atomic amounts of the "A" group.

The atomic amounts of the cations of the group "A" in the cubic titanium-tantalum niobates range from 2.0 to 0.5, a definite dependence between the size of the cation deficiency in the group "A" and the content of Ti, Zr, U, Th, and water in minerals having been observed. The usual minerals with an increased cation deficiency in the "A" group are metamict minerals.

Results of X-ray investigations of the isometric titanium-tantalum niobates are given in the paper and the dependence of the size of the elementary mineral cell on the Ti content has been established. On the basis of the ascertained regularities in the composition and structure of the isometric titanium-tantalum niobates a rational classification of minerals belonging to this group has been proposed. --Auth.

1-1755. Carroll, Dorothy. ION EXCHANGE IN CLAYS AND OTHER MINERALS: Geol. Soc. America, Bull., v. 70, no. 6, p. 749-79, 3 tables, June 1959, approx. 240 refs.; abstracts in English, French, German, and Russian.

Ion exchange in clays and other minerals is dependent on the crystalline structure of the mineral and on the chemical composition of any solution in contact with the mineral. The structures of clay minerals and zeolites are briefly described to provide a background for the discussion of their ion-exchange reactions. Ion exchange in these minerals is a reversible chemical reaction that takes place between ions held near a mineral surface by unbalanced electrical charges within the mineral framework and ions in a solution in contact with the mineral. Generally the excess charge on the mineral is negative, and it attracts cations from the solution to neutralize this charge. The chemical reactions in ion exchange follow the law of mass action, but the reactions are restricted by the number of exchange sites on the mineral and by the strength of the bonding of the exchangeable cations to the mineral surface. Titration of H-clays with bases shows that montmorillonites and "illites" behave like a mixture of 2 or 3 different acids, whereas kaolinite, with an indefinite number of exchange sites, behaves like an indefinite number of acids.

Ion-exchange capacity is measured in chemical equivalents of base adsorbed at pH 7. Each clay mineral has a range of exchange capacities because of differences in structure and in chemical composition. The ranges (in milliequivalents per 100 grams) are kaolinite, 3-15; halloysite ($2H_2O$), 5-10; halloysite ($4H_2O$), 40-50; montmorillonite, 70-100; "illite," 10-40; vermiculite, 100-150; glauconite, 11-20; attapulgite, 20-30; and allophane, 70. The common metallic cations found in exchange positions in clay minerals are Ca^{+2}, Mg^{+2}, Na^{+}, and K^{+}. At low pH values H^{+} replaces other cations. The order of replaceability of the common cations has been found to be:

$$Li^{+} < Na^{+} < K^{+} < Rb^{+} < Cs^{+} \text{ and } Mg^{+2} < Ca^{+2} < Sr^{+2} < Ba^{+2}.$$

Bivalent cations enter the exchange sites preferentially to univalent cations. The common exchangeable cation is most clay minerals in soils is Ca^{+2}.

Other exchange phenomena discussed are anion exchange, fixation of cations and anions by clay minerals, effect of environment on cation exchange, and the exchange capacity of zeolites, of rocks, of other minerals, of organic matter and organic complexes, and of amorphous mineral material. --Auth.

1-1756. Murdoch, Joseph, and Robert W. Webb. MINERALS OF CALIFORNIA: California, Div. Mines, Bull. 173, 452 p., illus., 1956, reprinted 1959.

Minerals of California, essentially a catalogue of mineral species, is the eighth and longest of the Division's series of lists of California minerals - a series inaugurated in 1884 with 135 mineral species. The current edition consists of 523 species.

In this bulletin, minerals are arranged in alphabetical order, so that only the name of the mineral need be known to find it immediately. Occurrences are listed by counties for each mineral; and when of particular importance or interest, are accompanied by a brief description of their geologic setting. Species first discovered in California are marked by an asterisk (*) and followed by the date of the first published description. Under each mineral, preceding the list of occurrences, is given a brief description, to assist in its identification without the use of elaborate equipment. The bibliography, containing some 2,000 titles, does not attempt to cover all notices of California minerals, but it is by far the most comprehensive yet assembled on California mineral occurrences. --C. W. Chesterman.

9. IGNEOUS AND METAMORPHIC PETROLOGY

1-1757. Moorhouse, W. W. THE STUDY OF ROCKS IN THIN SECTION: 514 p., 226 figs., 20 pls. (2 col.), 18 tables, New York, Harper & Brothers, 1959, refs.

The book has been planned with the purpose of providing in a single volume a brief review of the methods of optical mineralogy (with a minimum of optical theory), descriptions of the rock-forming minerals encountered in the more common rocks, identification tables to assist in the identification of these minerals, and descriptions of the common rock types. Object of the section on optical mineralogy is to present as briefly and simply as possible the optical tests most frequently used in thin-section mineralogy. Only the commoner rock-forming minerals are described in the mineralogical section. The minerals listed comprise over 99% of the constituents of the common rocks, so that for most routine petrographic work no other source will be necessary.

Chaps. 2-4 deal with mineralogy, Chap. 5 discusses the petrography of igneous rocks in general terms and provides tables of classification. Chaps. 6-10 are devoted to the volcanic and hypabyssal rocks, Chaps. 11-15 are concerned with rocks of plutonic type, and

Chaps. 16 and 17 with ultrabasic rocks and the lamprophyres. The sedimentary rocks in thin section are described in Chaps. 18-24, and the metamorphic rocks in Chap. 25. The rock groups considered in each chapter are systematically discussed under the following headings: definitions, mineralogy, texture, alteration, varities, petrogenesis, and economic geology. Chaps. 26-29 are concerned sequentially with dynamic, thermal, and regional metamorphism, and with metasomatism. The final chapter discusses the petrography of the ores.

A number of new features have been incorporated in the drawings of thin sections that accompany the text. Most of them have been drawn on a grid using a grating micrometer so as to reproduce the textures as accurately as possible. In most of the drawings a standard pattern has been used for each mineral or mineral group, so that labeling of the individual diagrams is not necessary. As many as possible of the common textural types of each major rock group have been included in the series of drawings. --From auth. pref. and introd. by C. Croneis.

1-1758. Buddington, A. F. GRANITE EMPLACEMENT WITH SPECIAL REFERENCE TO NORTH AMERICA: Geol. Soc. America, Bull., v. 70, no. 6, p. 671-747, 19 figs. incl. 16 maps, June 1959, approx. 280 refs.; abstracts in English, French, German, and Russian.

Publications of the last 25 years that discuss the emplacement of granite plutons are reviewed, with special reference to North America. The plutons are classified according to emplacement in the epizone, mesozone, or catazone of the earth's crust. It is found that those emplaced in the epizone are almost wholly discordant; those in the mesozone complex, in part discordant and in part concordant; and those of the catazone predominantly concordant. Granite formed by granitization is considered to be minor or local in plutons of the epizone, common but subordinate in those of the mesozone, and a major factor in plutons of the catazone. The authors of the papers reviewed in general, however, infer that magma was either directly or indirectly the major factor in all the zones. Contrary to some current theories, this review emphasizes the great number and great total volume of granitic plutons emplaced as fluid magma in the epizone and their community of origin with lavas of similar composition directly associated in time and space. Magma is thus inferred to play the major role in Tertiary stocks and batholiths. There appears to be no discontinuity between plutons of the epizone and those of the mesozone, and a major role for magma is indicated for the latter also. The evidence is not clear as to whether plutons of the mesozone are continuous with those of the catazone, have roots in the catazone, or are pinched off from it. Batholiths emplaced in the mesozone are dominant in most basement complexes of Precambrian to Early Cretaceous ages. --Auth.

1-1759. McBirney, A. R. FACTORS GOVERNING EMPLACEMENT OF VOLCANIC NECKS: Am. Jour. Sci., v. 257, no. 6, p. 431-48, 4 illus., 2 figs., 4 diags., 2 tables, June 1959, 21 refs.

Previously advocated processes are found inadequate to explain the rise of volcanic necks from magmatic sources to shallow levels where they can erupt on the surface. Comparisons of heat conduction of wall rocks with heat transfers of corresponding convection systems show that circulation of fluid magma is likely to take place. Rocks at the apex and walls of the intrusion can be disrupted by thermal stresses and removed as inclusions in downward flowing currents to provide space for the volume of rising magma. --Auth.

1-1760. Bayley, Richard W. A METAMORPHOSED DIFFERENTIATED SILL IN NORTHERN MICHIGAN: Am. Jour. Sci., v. 257, no. 6, p. 408-30, 11 figs. incl. 3 illus., 2 maps, 5 diags., 4 tables, June 1959, 20 refs.

An exceptionally thick differentiated metagabbro sill of middle Precambrian age has been found near Mansfield Location, Iron County, Michigan. This sill, known as the West Kiernan sill, intruded the sedimentary and volcanic rocks of the middle Precambrian Hemlock formation in late middle Precambrian time. The sill, differentiated after emplacement, was subsequently folded, and altered by low-grade regional metamorphism. Differentiation resulted from mineral fractionation and gravity sorting during crystallization. Igneous textures and structures throughout the sill indicate tectonic quiescence during the time of crystallization. Rhythmic layering in part of the sill indicates that convection currents were probably active locally during crystallization.

The rocks of the sill have been divided into 5 zones, each representing petrographically and chemically distinct types. These zones are, from bottom to top, ultramafic, normal metagabbroic, transitional, granophyric, and metadiabasic (chilled).

Although the mineral composition of the sill was greatly changed during regional metamorphism, its chemical make-up is believed to chiefly reflect variations imposed during differentiation. --Auth.

1-1761. Buckwalter, T. V. GRANITIZATION IN THE READING HILLS, BERKS COUNTY, PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 133-38, 3 figs., 1958.

Nearly similarly oriented xenoliths of hornblende gneiss in granite gneiss and granite pegmatite at Antietam Lake, Berks County, suggest that hornblende gneiss was granitized in place by acidic emanations which were not completely fluid at any single time. The orientation of the xenoliths conforms with that of other nearby crystallines. --Auth.

1-1762. Borodin, L. S. THE CHEMISTRY OF AEGIRINIZATION AND NEPHENILIZATION [SIC] OF PYROXENE IN THE FORMATION OF METASOMATIC NEPHELENE-PYROXENE ROCKS (LJOLITES): Geochemistry [Geokhimiya], 1958, pub. 1959, no. 5, p. 637-40, 4 refs.

Nephelinization may be expressed by the following reaction:

pyroxene → aegirinized pyroxene → nepheline
(partial withdrawal of Ca(Mg))
(complete withdrawal of Ca(Mg))
aegirinization → nephelinization

As a rule, pyroxenite is highly variable in its grain size. The infiltration of solutions into this rock should be highly variable accordingly. Insofar as the replacement of pyroxene by nepheline takes place only as a function of the dissolution of pyroxene, the progress of nephelinization is irregular, because only a part of the pore space of

the rock is filled by the reacting solutions. The resulting nephelinization "nucleii" determine further developments of the process. These relationships may serve to explain the petrographic characteristics of ijolite-melteigites; their irreguliarity of quantitative mineralogic composition, the alternations of essentially nepheline and essentially pyroxene areas (even within the same small rock fragment, and the presence of relicts of aegirinized pyroxenite.

At the same time, aegirinization involves a much greater volume of the rock, on account of the diffusion halo of Na in pyroxene crystal structures. In this manner, nephelinization and aegirinization, the 2 processes of the metasomatic alteration of pyroxene, are essentially concurrent. Their end product is a rock of the ijolite type consisting of nepheline and relict aegirinized pyroxene. --Auth.

1-1763. Ross, Donald C. IGNEOUS AND METAMORPHIC ROCKS OF PARTS OF SEQUOIA AND KINGS CANYON NATIONAL PARKS, CALIFORNIA: California, Div. Mines, Spec. Rept. 53, 24 p., illus., geol. map scale 1:62,500, 1958, 36 refs.

This report is a petrographic study of some metamorphic rocks and of 13 plutonic rock units exposed in about 150 sq. mi. on the western slope of the southern Sierra Nevada. The metamorphic rocks consist of schists, quartzite, marble, amphibolite, and metavolcanic rocks, and are described briefly. These rocks were regionally metamorphosed and then later affected locally by contact metamorphism and hydrothermal alteration. Each of the igneous plutons are described. In addition the following are presented: a tabular summary of mineral composition based on 136 thin sections; a tabulation of 76 modal analyses by the Chayes method, in which the plagioclase composition and the number of point-counts used are stated; and a graphical representation of these data on Johannsen triangular diagrams. The composition of the plutons ranges from gabbro to granite. Considerable variation was noted within each of the larger plutonic bodies; the small plutons, however, are characteristically of uniform mineral composition.

The ages of the metamorphic and plutonic rocks are unknown, but they are assumed to be Mesozoic. The plutons probably were emplaced without forceful intrusion.

A considerable portion of the report is devoted to a discussion of inclusions in the plutonic rocks. Rhythmic layering of hornblende crystals may have been caused by alternate crystal settling and sweeping by convection currents. Some dark inclusions probably were developed by recrystallization of gabbro and metamorphic rocks, but the origin of most of them is still unknown. --P. A. Lydon.

10. SEDIMENTARY PETROLOGY

See also: Stratigraphy 1-1668; Mineralogy 1-1755; Igneous and Metamorphic Petrology 1-1757.

1-1764. Brophy, John A. HEAVY MINERAL RATIOS OF SANGAMON WEATHERING PROFILES IN ILLINOIS: Illinois State Geol. Survey, Circ. 273, 22 p., 12 figs., incl. map, sec., 2 tables, 1959, 9 refs.

Heavy mineral ratios were studied to compare the degree of weathering attained in buried Sangamon profiles developed on Illinoian till with that in profiles developed on Illinoian outwash. Grain sizes were determined and heavy minerals were analyzed for 59 samples from 4 sections. Two of the sections were from profiles developed on clayey till and 2 from profiles developed on outwash, one of the latter being dominantly sand and gravel, the other silt overlying sand, silt, and gravel. The sections sampled had similar topographic positions so that differences in soil-forming factors, other than texture of parent material, probably were not great.

In terms of depletion of hornblende and garnet, the relatively coarse-grained, open-textured outwash proved to be considerably more weathered than the till. In the zone of greatest weathering about 90% of the hornblende had been removed from the outwash but only 60% had been removed from the till. About 70% of the garnet also had been weathered from the outwash, but the amount of garnet in the weathered till had not been noticeably reduced.

In the till profiles the original illite and chlorite were altered almost completely to montmorillonite. --Auth.

1-1765. Skolnick, Herbert, and Robert E. Arnal. VENTURA BASIN ENVIRONMENT: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 2, p. 477-84, map, Feb. 1959, 16 refs.

A paleontologic and petrographic analysis of claystone of the upper Miocene Castaic formation leads to the following conclusions: the eastern Ventura basin, California, was a partially landlocked bay with restricted circulation in late upper Miocene time. Organic material was deposited slowly in shallow depressions on a clay bottom. A dwarf Foraminifera fauna evolved. Radiolaria, diatoms, and pelagic Foraminifera were occasionally swept in from the open sea. After burial and completion of pyrite filling of the diatoms and radiolaria, their siliceous frustules and tests were dissolved leaving internal molds. Partial coalification resulted in a low-grade coallike material in thin seams in the marine claystone matrix. --M. Russell.

1-1766. Hall, W. Ellis. GENESIS OF "HAYMOND BOULDER BEDS," MARATHON BASIN, WEST TEXAS: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 1, p. 238-39, Jan. 1959, 5 refs.

Discussion of papers by P. B. King (U. S. Geol. Survey, Prof. Paper 187; Am. Assoc. Petroleum Geologists, Bull. v. 42, p. 1731-34). The "Haymond boulder beds" of the eastern Marathon Basin, W. Texas, owe their origin to tectonic movement. The genesis of the igneous, metamorphic, and sedimentary fragments within Haymond mudstones is unrelated to the genesis of the faulted, fractured, and weathered chert outcrops which characterize 2 "boulder bed" localities. The chert outcrops were brought to present position by folding and faulting and delineate the crest of faulted anticlines. The field evidence supports tectonic origin. Movements responsible for emplacement of the chert "boulder beds" are of post-Haymond age. --M. Russell.

1-1767. Rogers, John J. W. THE SIGNIFICANCE OF GRAIN SIZE DISTRIBUTIONS IN CLASTIC SEDIMENTARY ROCKS: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 197-99, 1958, 17 refs.

Clastic grains exhibit approximately lognormal size distributions in most sedimentary rocks. These lognormal distributions are essentially random ones and reflect the fact that most processes of erosion, transportation, and deposition affect only the medians and sorting coefficients, but not the fundamental shapes, of the size-frequency curves of sedimentary materials. Thus, normal sedimentary transportation and deposition can be considered as "nonselective" with regard to the fundamental shape of size distribution curves.

Nonnormal distributions can be detected most easily by plotting cumulative frequencies on logarithmic probability paper, which shows deviations from lognormality even in some sediments for which standard quartile measurements indicate a skewness of 1. Nonnormal distributions can be caused by a variety of processes, all of which may be classed generally as "selective." These processes include post-depositional elutriation of fine materials and rapid deposition of freshly weathered, little transported debris.

Size distributions of sedimentary rocks can be determined readily by sieving (for the bulk sediment) or by bromoform separation and grain counting (for the heavy minerals). Sediments which show nonnormal distributions can generally be presumed to have been affected by some special, selective process. The identification of such processes is of great importance in analyzing the geologic history of a sediment and determining its mode of formation. --Auth.

1-1768. Dumont, Benoît, and Louis Edmond Hamelin. ÉTUDE GRANULOMÉTRIQUE DE SABLES DES ÎLES-DE-LA-MADELEINE (P.Q.) [GRANULOMETRIC STUDY OF SANDS OF ÎLES-DE-LA-MADELEINE (P.Q.)]: Cahiers de Géographie de Québec, v. 3, no. 5, p. 73-76, illus., graphs, 2 tables, Oct. 1958-March 1959, 6 refs.

This paper summarizes the first results of laboratory investigations on material consisting of medium sized sands. Studies of the shape and appearance of the grains and of their dimensions suggest lithologic and polygenetic influences. In the Quaternary, the sequence of the main stages could have been as follows: the grains could have been angular, then partially rounded, then subjected to severe wind action. Frost action, the sea, and the wind seem to have been the corresponding processes. The evidence of land forms as well as the regional conditions of morphological evolution are in accord with this simplified sequence. Our studies are not advanced enough to say anything further. --Auth. concl. (transl.).

1-1769. Scholl, D. W. EXPOSURES OF SAN ONOFRE BRECCIA ON ANACAPA ISLAND, CALIFORNIA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 1, p. 222-23, Jan. 1959, 7 refs.

Two strata of Miocene San Onofre breccias, interbedded with Conejo volcanics, crop out on Anacapa Island, California (approx. 34° 00'30" N., 119°19'-27' W.). The sedimentary breccias are composed of blocks and angular cobbles and pebbles of glaucophane schists, hornblende schists, chloritic and talcose schists, and pink quartzites surrounded by a sandy to silty matrix of metamorphic minerals and rock fragments. Intercalcated with the breccias are pink and light green silty sandstones composed of mineral and rock fragments common to the coarser breccia beds. Both breccia units have maximum thickness of about 35-40 ft. and dip between 5° and 15°N. Where extrusive rocks overlie the breccia units, a baked or altered zone a few centimeters thick exists at the contact of the 2 lithologic units. Inclusions of contorted shales are abundant in the extrusive rocks between the breccia units. Exposures of San Onofre breccia have been recognized near Point Dume, 35 mi. E. of Anacapa Island and on Santa Cruz Island, about 4 mi. W. --A. C. Sangree.

1-1770. Archbold, N. L. RELATIONSHIP OF CARBONATE CEMENT TO LITHOLOGY AND VANADIUM-URANIUM DEPOSITS IN THE MORRISON FORMATION IN SOUTHWESTERN COLORADO: Econ. Geology, v. 54, no. 4, p. 666-82, 12 figs. incl. geol. map, secs., 4 tables, June-July 1959, 4 refs.

Carbonate content was determined for 888 samples from the Salt Wash member of the Morrison formation [Late Jurassic] in the Slick Rock and Uravan mining districts in southwestern Colorado. The carbonate content of most samples was determined semiquantitatively by calculating the amount of calcite equivalent to the mass of carbon dioxide evolved when the samples were treated with 3 normal hydrochloric acid. The content of some samples was determined in the course of standard chemical assays, and the content of others was visually estimated.

Samples were assigned to categories or "rock types" on the basis of gross lithology, V-U content, degree of epigenetic alteration, and degree of oxidation through weathering. The average carbonate content was determined for each rock type, and the distribution of carbonate around oxidized and unoxidized ore was investigated.

Results indicate that sandstone in the uppermost (ore-bearing) part of the Salt Wash member contains 2.5 to 3.0% carbonate, whereas sandstone in the lower (generally barren) part of the Salt Wash member contains about 13% carbonate. Altered mudstone in the Salt Wash member contains about 4% carbonate, and unaltered mudstone about 7%.

Carbonate-rich zones in sandstone adjacent to contacts with mudstone may be of syngenetic or early diagenetic origin, whereas carbonate-rich zones associated with ore bodies may be genetically related to the ore deposits.

Where the sandstone has been subjected to weathering, the overall distribution of carbonate does not seem to have been greatly affected. --Auth.

1-1771. Gorbunov, N. I. MINERALOGICAL AND CHEMICAL COMPOSITION OF THE SILT FRACTION OF SOME SOILS, SOIL-BUILDING ROCKS, AND DISPERSED MATERIAL OF RIVERS IN THE KURA-ARAXES LOWLAND. Translated by Salih Faizi: Internat. Geology Rev., v. 1, no. 4, p. 48-74, 12 figs. incl. illus., 15 tables, Apr. 1959, 21 refs.

The physical, mineralogical, and chemical properties of soils, soil-building rocks, and dispersed materials of rivers in the Kura-Araxes lowland, U.S.S.R. [42°N. 48°30'E.], are dependent upon the quantity and quality of organic substances contained, distribution and characteristics of silt and colloidal fractions, and amount and composition of bases and salts absorbed in the soils. These characteristics affect swelling, maximum hygroscopic capacity, and

hardness.

Iron-oxide films on the surfaces of microaggregates increase soil stability, essentially maintained by capillary forces and by swelling of hydrophilic colloids. During irrigation, soils increase in volume; non-structured soils become packed when dry. Crust building involves soil swelling, soil-lump soaking and destruction by enclosed or adsorbed air, soil packing, and hardening with simultaneous shrinkage and cracking.

Slow irrigation along furrows, subsoil irrigation, and rain-making are recommended for the prevention of crust building, as are other general agrotechnical measures. --Ed. abs.

1-1772. Kornicker, Louis S. BAHAMIAN LIMESTONE CRUSTS: Gulf Coast Assoc. Geol. Soc., Trans. v. 8, p. 167-70, 5 figs., table, 1959, 10 refs.

Limestone crusts are extensively developed on the cays of the Great Bahama Bank. These are formed by induration of the rock through recrystallization and cementation. The crusts are probably formed above the intertidal zone. The resemblance of some laminated crusts to soft algal mats now forming in the intertidal zone is considered to be, for the most part, coincidental. Crusts are geologically important in protecting underlying, less resistant rock from erosion. Differentiation of 2 generations of intertidal features is possible if one generation is encrusted. --Auth.

1-1773. Vyalov, O. S., and L. G. Tkachuk. ON SEDIMENTARY FORMATIONS FROM CAPETOWN AND MORAINES OF THE ANTARCTIC. Translated by Victor H. Winston: Internat. Geology Rev., v. 1, no. 4, p. 26-30, table, Apr. 1959, 11 refs.

Cemented psammites were collected by O. S. Vyalov from Antarctic moraines and from outcrops in the vicinity of Capetown, South Africa, and were analyzed by L. G. Tkachuk. Comparison of the psammites - their chemical, mechanical, and paleontological composition - indicates the similar conditions of rock formation which prevailed in the vicinity of Capetown and in parts of Antarctica. Also, it is possible that sedimentary rocks from South Africa contributed to the drift area which supplied morainal material to parts of Antarctica. The results of this comparison are interesting in view of the assumed existence of a single Gondwana continent in the Paleozoic. --Auth. abs.

11. GEOHYDROLOGY

See also: Geophysics 1-1720; Geochemistry 1-1741.

1-1774. Todd, David K. GROUND WATER HYDROLOGY: 336 p., 156 figs. incl. illus., maps (1 fold.) diags., graphs, 23 tables, New York, John Wiley & Sons, Inc.; London, Chapman & Hall, Ltd., 1959, approx. 700 refs.

The purpose of the book is to present the fundamental principles, methods, and problems of ground-water hydrology in a manner understandable to those most concerned with such knowledge: civil engineers, geologists, agricultural and irrigation engineers; also those in fields of mining, petroleum engineering, forestry, public health, law. The book presupposes only a background of mathematics through calculus and an elementary knowledge of geology.

Contents are based on a broad interpretation of ground-water hydrology in order to embrace all elements of ground water as a water supply source. The first 6 chapters cover the basic quantitative aspects of the subject, including use, occurrence, movement, hydraulics, water wells, and ground-water levels. Chap. 7 presents ground-water quality, with emphasis on measures of water quality and interpretation of water analyses. Chap. 8 is concerned with the conservation of ground water. Methods for investigating ground water by surface and subsurface procedures are described in Chaps. 9 and 10. Two important problems unique to ground-water hydrology are artificial recharge and sea-water intrusion; these are discussed in Chaps. 11 and 12. Chap. 13 provides an introduction to ground-water rights. The final chapter contains a review of the various types of laboratory model and numerical analysis studies that have become valuable ground-water research tools. An appendix lists useful conversion factors and constants. At the end of each chapter is a list of selected references pertaining to the specific topic treated. --From auth. pref.

1-1775. Alexander, G. N. RETURN PERIOD RELATIONSHIPS: Jour. Geophys. Research, v. 64, no. 6, p. 675-82, 5 tables, June 1959, 14 refs.

The samples available in hydrology are often so small that it is desirable to take their size into account when estimating parameters. By using a simple classical model the relationship between various estimates of return periods derived from hydrologic time series has been obtained. Results for the "annual" and "base stage" series are compared with values given previously for a "complete" series and also with empirical values used by the U. S. Weather Bureau. Effects of departures from the model assumed, caused by seasonal variation in probability of occurrence, or by correlation in magnitude, are reconciled with observed results. --Auth.

1-1776. Smirnov, A. A. THE GENESIS OF CO_2 IN GROUND WATER CONTAINING CARBONIC ACID. Translated by Dean A. Miller: Internat. Geology Rev., v. 1, no. 4, p. 75-79, Apr. 1959, 8 refs.

Answers to criticisms of a paper concerning the genesis of CO_2 made by V. P. Novik-Kachan and A. V. Zhevlakov treat the manufacture of CO_2 contained in air and water circulating through tectonic fractures, thermodiffusion of various gases having different molecular weights and under varying degrees of temperature and pressure, and variations in CO_2 concentration due to external seasonal variations in temperature and protective snow cover. --Ed. Abs.

1-1777. Deutsch, Morris, E. M. Burt, and K. E. Vanlier. SUMMARY OF GROUND-WATER INVESTIGATIONS IN THE HOLLAND AREA, MICHIGAN: Michigan, Geol. Survey Div., Prog. Rept. 20, 87 p., 7 maps (1 fold.), chart, cross sec., fold. diag., 5 graphs, 10 tables, 1958, 14 refs.

Ground water in the Holland area is contained in consolidated rocks of Paleozoic age and in unconsolidated glacial deposits which mantle the consolidated rocks in most of the area.

In the northeastern part of the area the Marshall formation yields small amounts of potable water. Ground water in other consolidated rocks is too highly mineralized for human consumption.

The glacial-drift aquifers, which are the chief sources of ground water in the area, consist of 2 major types of material: shallow outwash which is included in, and interbedded with, sandy and clayey lake deposits; and buried outwash which fills valleys cut into the Paleozoic formations in preglacial time. These deposits were the only sources of water used by the city of Holland during the period 1883 through 1956. Prior to 1921, only the shallow outwash was used as a source of municipal supply, and it is still the source of water for many domestic and industrial wells. In the period 1921 to 1956, most of the Holland municipal supply came from buried outwash aquifer of the East Channel which underlies the area E. of Holland. Another buried channel filled with outwash deposits (aquifer of the South Channel) underlies the southeastern part of the area, but water from this aquifer is too highly mineralized for most uses. It has been difficult to obtain even small supplies of good quality water from parts of the area underlain by the South Channel.

Water from the shallow outwash aquifers is generally of good chemical quality, although these deposits are subject to contamination from sewers and surface sources. Prior to extensive development, the water produced from the aquifer of the East Channel was similar in chemical quality to the water in the shallow outwash. , As water levels declined in response to pumping, the mineral content of the water increased. This increase probably represents migration of water from the Coldwater shale.

Because it was doubtful that the aquifers of the Holland area would yield water of good quality in sufficient quantity for anticipated demands, the city of Holland decided to utilize the water of nearby Lake Michigan. --Auth.

1-1778. Taylor, George C., Jr. GROUND-WATER PROVINCES OF INDIA: Econ. Geology, v. 54, no. 4, p. 683-97, map, June-July 1959.

This paper gives a general resumé of ground-water utilization and development and describes the occurrence of water in 8 ground-water provinces of India. The paper is based in part on observations of the writer during 1951-55 and in part on earlier work of the Geological Survey of India.

Ground water has been utilized extensively in India since before the beginning of the Christian era. Currently (1956) ground water is an important source of supply for domestic, stock, municipal, and industrial needs throughout the Republic and is widely used for irrigation in the Peninsular and Ganges-Brahmaputra regions W. of longitude 85°. Dug, bored, and drilled wells are the principal means by which ground water is developed, although locally infiltration tunnels or improved springs are used. Methods of lifting or pumping water from wells include the hand line and bucket, the hand-lift pump, the counterpoised sweep, bullocks, and "mote," the water wheel, horizontal and vertical centrifugal pumps, and deep-well turbine pumps. The most common device for lifting water for irrigation is still the time-honored bullock and "mote" (leather bag). However, in modern India there is increasing use of mechanical pumps.

With respect to the occurrence of ground water, India can be divided into 8 provinces, lying in 3 major regions, (1) the Peninsular region, (2) the Ganges-Brahmaputra region, and (3) the Himalayan region. The Peninsular region contains 6 ground-water provinces. Precambrian igneous, metamorphic, and indurated sedimentary rocks and early Tertiary volcanic rocks in 3 of these provinces yield many small supplies of water, which generally is of good quality but locally is brackish or salty. Cretaceous water-bearing sandstones in another province are moderately productive and in places are developed for large water supplies. Late Tertiary and Quaternary water-bearing sands and gravels in 2 other provinces sustain many small water supplies and several large water supplies - particularly in the coastal areas of southern India. The Ganges-Brahmaputra region is a single ground-water province in which many tens of thousands of small water supplies and several thousand large supplies are obtained from water-bearing sands and gravels in late Tertiary and Quaternary alluvium. This province constitutes a vast ground-water reservoir, which is the most productive in India. The Himalayan region also is considered as a single province, in which ground water occurs in a series of narrow valleys filled with moderately to highly permeable Quaternary alluvium. These alluvial valleys transmit large quantities of water to the ground-water reservoir in the Ganges-Brahmaputra region. --Auth.

12. MINERAL DEPOSITS

See also: Geologic Maps 1-1606, 1-1611, 1-1612, 1-1613; Areal and Regional Geology 1-1621; Geophysics 1-1698, 1-1733; Geochemistry 1-1736, 1-1737, 1-1745, 1-1749; Mineralogy 1-1753; Sedimentary Petrology 1-1770; Engineering Geology 1-1864.

1-1779. Hawkins, D. B., F. C. Canney, and Frederick N. Ward. PLASTIC STANDARDS FOR GEOCHEMICAL PROSPECTING: Econ. Geology, v. 54, no. 4, p. 738-44, tables, June-July 1959, 6 refs.

Plastic standards for use in geochemical prospecting have been prepared by impregnating a clear thermosetting resin with different amounts of a stable dye or colored metal complex. The colored plastic is molded or subsequently milled into convenient shapes to form standards that are less bulky and more stable than the liquid standards conventionally used in rapid field methods. The use of such standards is limited only by the availability of stable coloring materials. The preparation of plastic standards for use with Cu, Zn, Sn, and Hg field procedures is described. --Auth.

1-1780. Tremari, A., and Paul I. Eimon. PHOTOGRAMMETRIC METHODS AND THE OPEN PIT MINE: Mining Engineering, v. 11, no. 5, p. 497-501, 8 illus., table, May 1959, 10 refs.

Photogrammetric methods make it possible to produce: accurate periodic maps; cross sections for computations; prints for geologic interpretation; an accurate record of conditions at a given date; and improved surveying efficiency. Choice of aerial or terrestrial photography depends primarily on physical layout of mine plus map requirements. Such methods are now in use by German coal mines at Bingham Can-

yon, Utah, and by TVA for coal stockpile inventory. --Auth.

1-1781. Vaughn, W. W., R. H. Barnett, and E. E. Wilson. DRILL CORE SCANNER PROVED IN FIELD: Mining Engineering, v. 11, no. 6, p. 617-20, 8 figs. incl. illus., diags., graphs, June 1959, 7 refs.

An instrument that scans a moving train of drill core for radioactivity has been constructed and tested. The instrument will accept drill core from 1 to 3 in. in diameter by way of a continuous conveyor belt and will provide a permanent record of radioactivity as a function of core length. Use of chemically assayed samples containing U in equilibrium with its decay products makes possible a calibration curve whereby the equivalent U content of an unknown sample may be determined. The counting chamber has essentially 3π geometry and is shielded by Pb walls 2 in. thick. Four sodium iodide crystals 2 in. in diameter by 2 in. thick and 4 photomultiplier tubes are used as the detecting elements. Although the core scanner was designed primarily to measure radioactivity in a continuously moving train of drill core, it may be used with equal effectiveness when properly calibrated to analyze crushed sample material in cylindrical cardboard containers. The sensitivity of the instrument is such that a variation in equivalent uranium oxide content of 0.01% will give a corresponding change of 50 counts per second in the recorded counting rate. Semiquantitative results are achieved with sample material containing as little as 0.005% eU_3O_8. --Auth.

1-1782. Wood, Ralph E. X-RAY MINERAL ANALYSIS TECHNIQUES: Mining Engineering, v. 11, no. 6, p. 602-604, 4 figs., 2 tables, June 1959, 6 refs.

A survey of applications of X-ray fluorescence analysis techniques to problems of exploration and mining. Emphasis is placed on rate, accuracy, and expense compared with conventional wet chemical methods. --Auth.

1-1783. Schwartz, George M. THE SOURCE BED CONCEPT: Econ. Geology, v. 54, no. 4, p. 745-48, 1959.

Exception is taken to C. L. Knight's generalization (Econ. Geology, v. 52, p. 808-817) that the great majority of sulfide ores are related to syngenetic sulfides in sediments. The evidence of 19 of the largest sulfide deposits in the western United States is cited against the source bed concept.

The conclusion is that syngenetic and epigenetic modes of origin of ores are not in opposition but are complimentary. --M. Russell.

1-1784. Stanton, R. L., and R. D. Russell. ANOMALOUS LEADS AND THE EMPLACEMENT OF LEAD SULFIDE ORES: Econ. Geology, v. 54, no. 4, p. 588-607, 5 figs., 3 tables, June-July 1959, 15 refs.

In several papers published since 1954 by one of us, suggestions have been made concerning the genesis of a certain class of lead-bearing sulfide ore body of the conformable type. Such deposits are thought to have been derived from seaboard volcanism and to have been emplaced in offshore, largely volcanic, sequences, during sedimentation and diagenesis. The metals are considered to have come directly from a deep source - probably the basaltic layer or mantle.

Recently it has been found that the isotope ratios of leads of several such deposits are apparently "ordinary" and extremely uniform, and the leads have suffered no detectable contamination with crustal radiogenic lead. This suggests that they may indeed have come from deep source and that they have been in contact with crustal rocks for no more than a very short time prior to deposition. In contrast the leads of some vein deposits are anomalous and highly irregular, suggesting significant radiogenic contamination. Apparently the leads of the conformable deposits (and some orthomagmatic leads) have been brought to the surface directly from below the continental crust and rapidly isolated and shielded from crustal materials, whereas those of the veins may have spent a considerable time in contact with the latter.

It appears, too, that the occurrence of ordinary and anomalous leads may give important general information on the history of galena-bearing deposits, and that leads from deposits of the conformable type may indicate, with good precision, the age of the sediments enclosing them. --Auth.

1-1785. Park, Charles F., Jr. THE ORIGIN OF HARD HEMATITE IN ITABIRITE: Econ. Geology, v. 54, no. 4, p. 573-87, 8 illus., sec., June-July 1959, 48 refs.

Great confusion exists in the interpretation of field evidence concerning the origin of masses of hard hematite in itabirite. The evidence is briefly reviewed, and some additional observations are recorded. The conclusion reached is that deposits of hard ore in itabirite commonly result from normal weathering processes. Supergene deposits of hard ore are more numerous and more widespread than are deposits of metamorphic or of other modes of origin. --Auth.

1-1786. Schmitt, Harrison A. THE COPPER PROVINCE OF THE SOUTHWEST: Mining Engineering, v. 11, no. 6, p. 597-600, map, June 1959, 16 refs.

One of the great Cu-producing areas of the world is comprised of 5 U. S. western states and northern Sonora, Mexico. The SW. province of this area, covering southern Arizona, southwestern New Mexico, and northern Sonora, produces 55% of U. S. Cu output and the equivalent of 15% of world production. In 1956 the area produced about 550,000 tons. --Auth.

1-1787. Atomnaya Energiya. THE GEOLOGY OF URANIUM. Translated from Russian Voprosy Geologii Urana, Supplement no. 6 of the Soviet Journal of Atomic Energy, Atomnaya Energiya, Atomic Press, Moscow, 1957: 128 p., illus., secs., graphs, tables, New York, Consultants Bureau, 1958, refs.

A collection of 12 papers dealing with the origin of uranium deposits, uranium mineralogy, and methods of investigation, published by Soviet investigators in 1957. Each of the papers is abstracted separately below in the order in which it appears in the book.

1-1788. Karpenko, V. S. METAMORPHISM OF URANIUM ORES: (In: Atomnaya Energiya. The Geology of Uranium: p. 1-13, 13 figs., table, New York, Consultants Bureau, 1958) 20 refs.

U deposits occurring in gently dipping strongly

metamorphosed upper Paleozoic sediments are described in detail. The ore, which consists of uraninite, chalcopyrite, and minor pyrite, is found chiefly in thinly banded black silty sandstones. Mineralization of the host rock is distinctly bedded with locally enriched lenses, layers, and nodules. A diabase intrusive that cuts the most rocks is shown to be unrelated to the U mineralization. Although the geologic, petrographic, and mineralogical characteristics of these deposits do not conclusively invalidate a hydrothermal origin, the author concludes that metamorphism resulted in the redeposition and concentration of syngenetically deposited U. --C. W. Field.

1-1789. Getseva, R. V. THE NATURE OF SEDIMENTARY-METAMORPHIC URANIUM MINERALIZATION: (In: Atomnaya Energiya. The Geology of Uranium: p. 14-28, 6 figs. incl. illus., sec., table, New York, Consultants Bureau, 1958) 11 refs.

The author describes the occurrence of U ore deposits in weakly metamorphosed lower Paleozoic dolomitized limestones, micaceous-argillaceous shales, and black shales. Low grade metamorphism of varying intensity was the active mechanism concentrating U of syngenetic origin originally dispersed throughout the sediments. The adsorption bond between syngenetic uranium oxides and organic-rich sediments was destroyed by regional metamorphism. The U then migrated along porous zones to favorable sites of deposition. --C. W. Field.

1-1790. Nekrasova, Z. A. THE ORIGIN OF URANIUM MINERALIZATION IN COAL: (In: Atomnaya Energiya. The Geology of Uranium: p. 29-42, 10 illus., 5 secs., 2 tables, New York, Consultants Bureau, 1958) 20 refs.

U mineralization of Jurassic coal strata is localized within low rank coals adjacent to coarse-grained permeable sandstones. An epigenetic-infiltration process is proposed for these deposits whereby U derived from the weathering of nearby granites was deposited by ground-water solutions in pyritic organic-rich sediments. --C. W. Field.

1-1791. Polikarpova, V. A. NEW DATA ON NENADKEVITE: (In: Atomnaya Energiya. The Geology of Uranium: p. 43-55, 10 illus., graph, 6 tables, New York, Consultants Bureau, 1958) 7 refs.

Nenadkevite is a primary U mineral found principally in zones of Na metasomatism. It is composed of quadrivalent and hexavalent U, silica, rare earth elements, Ca, Mg, Pb, and water. U may interchange with Ca and Mg, and this substitution imparts a darker color to the mineral as well as an increase in specific gravity and index of refraction. The Pb is of radiogenic origin, and Th is invariably present in small amounts.

It is possible that the mineral is an end-member of the series thorite-uranothorite-nenadkevite. --C. W. Field.

1-1792. Nekrasova, Z. A. THE HYDROUS URANYL AND AMMONIUM PHOSPHATE (URAMPHITE) - $NH_4(UO_2)[PO_4] \cdot 3H_2O$: (In: Atomnaya Energiya. The Geology of Uranium: p. 56-60, 3 illus., graph, 3 tables, New York, Consultants Bureau, 1958).

Uramphite is a pale green mineral found in the oxidized zone of U coal deposits. It occurs as small rosettes, lichen-like aggregates, and dense patches on fractures in the coal. The author attributes its formation to solutions containing abundant ammonium ion, derived from the decay of organic matter, circulating in the zone of oxidation. --C. W. Field.

1-1793. Chernikov, A. A., O. V. Krumetskaya, and V. D. Sidelnikova. URSILITE - A NEW SILICATE OF URANIUM: (In: Atomnaya Energiya. The Geology of Uranium: p. 61-65, 3 illus., 3 tables, New York, Consultants Bureau, 1958) 3 refs.

Ursilite is a lemon-yellow uranium silicate forming earthy or nodular incrustations along joints in quartz porphyries. It is commonly associated with kaolinite and calcite and more rarely with uranophane, sklodowskite, and kaolinite. Ursilite is a member of a Ca-Mg isomorphic series and is distinguished from other uranium silicates by its optical properties. --C. W. Field.

1-1794. Chernikov, A. A. CONDITIONS OF FORMATION OF NATROAUTUNITE: (In: Atomnaya Energiya. The Geology of Uranium: p. 66-69, sec., table, New York, Consultants Bureau, 1958) ref.

This mineral was discovered by the author in a fault zone cutting granodiorite. Numerous hypogene minerals occur in this zone but natroautunite was the only U mineral found between 3 and 10 m. depth. Groundwater analyses suggest that natroautunite forms where Na is more abundant than Ca as the cation in the circulating waters of this zone. --C. W. Field.

1-1795. Sidorov, G. P., and R. P. Rafalskiy. HYDROTHERMAL SYNTHESIS OF URANINITE: (In: Atomnaya Energiya. The Geology of Uranium: p. 70-73, 6 figs., New York, Consultants Bureau, 1958).

The authors synthesized uraninite crystals by placing a slice of shale and several milliliters of uranyl sulfate in a quartz flask, evacuating the flask, heating it for several days at 300° C., and plunging the container in cold water. Uraninite was observed to precipitate chiefly in those parts of the shale containing abundant organic matter. Some uraninite formed metasomatically within the organic-rich shales by partly replacing the quartz in the interstices between grains. --C. W. Field.

1-1796. Ambartsumyan, Ts. L. THERMAL INVESTIGATIONS OF SOME URANIUM MINERALS: (In: Atomnaya Energiya. The Geology of Uranium: p. 74-102, 24 figs., New York, Consultants Bureau, 1958) 7 refs.

This paper presents a systematic study of the physiochemical properties of 10 minerals characterized by hexavalent U. In addition to thermal and dehydration analyses performed on these minerals, the author has included optical, X-ray, fluorescent, and chemical data. These minerals undergo profound transformations with increasing temperature, and dissociate with the separation of uranium oxides on melting. However, the lattices of nonvolatile cation-bearing minerals are found to more temperature resistant. --C. W. Field.

1-1797. Shashkin, V. L., and I. P. Shumilin. THE RADIOMETRIC METHOD OF DETERMINING URANIUM CONTENT IN ORE SAMPLES: (In:

Atomnaya Energiya. The Geology of Uranium: p. 103-110, illus., 4 tables, New York, Consultants Bureau, 1958) 8 refs.

The authors present the theoretical background, apparatus, procedure, and current status of the beta-gamma radiometric method for determining U content in ore samples. The results of their radiometric analyses are found to be as precise as chemical analyses utilizing the phosphate method. --C. W. Field.

1-1798. Shashkin, V. L., I. P. Shumilin, and M. I. Prutkina. THE RATIO OF β - AND γ - RADIATION IN NATURAL RADIOACTIVE ELEMENTS: (In: Atomnaya Energiya. The Geology of Uranium: p. 111-118, 6 graphs, 4 tables, New York, Consultants Bureau, 1958) 5 refs.

When making radiometric determinations of radioactive elements, it is necessary to know the ratios of beta and gamma radiation for the different elements of the equilibrium U series, and equilibrium Th and K. Since theoretical calculation of these ratios and calculation of the spectral sensitivity of counters are complex and yield results of unsatisfactory precision, they are best obtained through experimental determinations. The authors present their experimental data for counters of varying wall thickness and utilizing both Al and Pb filters. --C. W. Field.

1-1799. Ter-Oganesov, Ya. G., T. I. Gvaima, Yu. V. Roshchin, and V. I. Zubova. METHODS AND TECHNIQUES OF AEROGEOPHYSICAL PROSPECTING FOR URANIUM DEPOSITS IN FOREIGN COUNTRIES: (In: Atomnaya Energiya. The Geology of Uranium: p. 119-28, illus., New York, Consultants Bureau, 1958) 48 refs.

This paper consists chiefly of a review compiled from foreign literature of methods, techniques, and apparatus used for airborne geophysical prospecting for U deposits in the United States, Canada, and Australia. --C. W. Field.

1-1800. Bosazza, V. L. THE OCCURRENCE OF URANIUM IN ANCIENT CONGLOMERATES: Econ. Geology, v. 54, no. 2, p. 313-25, 2 tables, Mar.-Apr. 1959, 23 refs.

Discussion of a paper by C. F. Davidson (Econ. Geology, v. 52, no. 6, p. 668-93). The evidence for detrital or hydrothermal origin of mineral deposits in the Transvaal and Southern Rhodesia is based on consideration of:

1. The Transvaal-Southern Rhodesian gold province, and the Witwatersrand Au-U ores.
2. The Au distribution in hydrothermal reefs and a comparison with the Witwatersrand and Tarkwaain bankets.
3. Wall-rock alteration in hydrothermal deposits.
4. Ore shoots in hydrothermal deposits of Kolar, Ghana, and Southern Rhodesia.
5. The nature of the Au and uraninite in the banket and the survival of various minerals.
6. The permeability of Witwatersrand conglomerates and adjoining rocks.

The conclusion is that Au and U are only very minor constituents of the banket and that the more abundant constituents are mainly detrital. Only the U, Au, and perhaps the Pt metals can be hydrothermal. Even the very rare diamonds are detrital.--M. Russell.

1-1801. Pegg, Charles W. THE OCCURRENCE OF URANIUM IN ANCIENT CONGLOMERATES: Econ. Geology, v. 54, no. 2, p. 325-35, sec., Mar.-Apr. 1959.

Discussion of a paper by C. F. Davidson (Econ. Geology, v. 52, no. 6, p. 668-93). Geology has always been and probably always will be an inexact science. Field observations and relationships that are obvious to the naked eye and to good old-fashioned common sense should be accepted in preference to geochemical evidence and to age determinations, since the rocks and minerals concerned have generally been subjected to many later metamorphisms. Geologists of today are forgetting the importance of field evidence.

In the case of the Au-U bankets there is little sound evidence for either theory in Blind River (Ontario), Rum Jungle (Australia), or the Sierra de Jacobina (Brazil), but field evidence from the Witwatersrand is overwhelmingly in favor of the placer hypothesis. --From auth. concl.

1-1802. Roscoe, S. M. ON THORIUM-URANIUM RATIOS IN CONGLOMERATES AND ASSOCIATED ROCKS NEAR BLIND RIVER, ONTARIO: Econ. Geology, v. 54, no. 3, p. 511-12, 1959, 3 refs.

Exception is taken to a generalization by C. F. Davidson (Econ. Geology, v. 52, no. 6, p. 889-90) that Blind River conglomerates contain much more U than Th. Data are given on which to base the conclusion that in the Blind River area, the sedimentary rocks as a whole, and the ore-bearing stratigraphic unit, contain considerably more Th than U, principally in monazite. --M. Russell.

1-1803. Sheldon, R. F. MIDNITE MINE GEOLOGY AND DEVELOPMENT: Mining Engineering, v. 11, no. 5, p. 531-34, illus., 2 figs., May 1959, 4 refs.

U ore bodies of the Midnite mine [Spokane Indian Reservation, Washington], which are localized along the contact between granitic intrusive rocks and metamorphosed sedimentary rocks, constitute the largest known deposit of this type in America. It is anomalous that the site of the initial discoveries still represents the only appreciable deposit of its kind found in the surrounding region, despite extensive prospecting of the contact zone for many miles. --Auth.

1-1804. Archibald, R. S. ECONOMIC HISTORY OF THE LAKE SUPERIOR IRON DISTRICT: Mining Engineering, v. 11, no. 5, p. 513-20, 3 maps, graph, 3 tables, May 1959.

Accompanying this report is a chart showing estimated requirements of Fe ore in the United States over a period of 30 years beginning with 1957, and the sources from which such requirements will be met. The chart shows a continued and rapid growth of the steel industry in the United States. It will be noted that underground production from the Lake Superior district continued almost in a horizontal line over this period. There is rapid depletion of the Minnesota open pit direct-shipping and gravity concentrates, and a rapid increase in production of taconite concentrates. Cost per unit of plants for producing taconite concentrates is very high, and it is doubtful that taconite production will increase as rapidly as shown on the chart. The balance of reserves required for the steel industry will have to come from Canadian and other foreign imports. --Auth.

1-1805. California, Div. Mines. NIOBIUM (COLUMBIUM) AND TANTALUM: Its: Mineral Inf. Service, v. 12, no. 3, p. 1-3, illus., March 1959, 15 refs.

Nb and Ta were announced as new elements in the early 19th century; in this century they have become necessary to our industrial economy. They are found in several complex mineral groups, of which the columbite-tantalite series has been the most important source. Minerals of the series have been found in placer deposits (with cassiterite) and in pegmatite dikes. Though the principal production is from other countries, a placer deposit in Idaho was opened in 1955, and other states have contributed commercial quantities.

The commodities are on the eligible list for federal loans under the administration of the Office of Minerals Exploration. --M. H. Rice.

1-1806. California, Div. Mines. LIMESTONE, DOLMITE, AND LIME PRODUCTS: Its: Mineral Inf. Service, v. 12, no. 2, p. 1-15. 7 illus., map, 4 tables, Feb. 1959, 9 refs.

California's multimillion dollar lime, limestone, and cement industry depends upon raw materials of limestone, dolomite, magnesite, seashells, travertine, marl, and caliche, all of which are available in California. Of the group, limestone and dolomite are the most widely used by the state's 51 producers. The principal areas of the state where carbonate rocks are available and reasonably accessible are: (1) the Klamath Mountains of Shasta and Siskiyou counties; (2) the foothill belt of the Sierra Nevada from Placer to Tulare County; (3) the Santa Cruz, Gabilan, and Santa Lucia mountains of the central Coast Ranges; (4) the Tehachapi Mountains; (5) the Victorville-Oro Grande-Adelanto district of the Mojave desert; (6) the Argus Range in Inyo County; (7) the San Bernardino Mountains near Lucerne Valley, and (8) the San Jacinto Mountains.

Though techniques for the separation of mixed materials have been worked out, they have not yet been successfully applied in California. Consequently, undesirable materials are of considerable concern to the industry. Igneous intrusions add such minerals as quartz, or garnet, to the limestone. Other troublesome ingredients are chert, which can be recognized by its hornlike texture and resistance to weathering, and replacement dolomite, recognizable by its elephant's-skin appearance on the weathered surface.

Both quarrying and underground methods have been used in mining carbonate rocks, most of which are further crushed and sized. Those that are calcined are sent to either vertical or rotary furnaces.

Prices have ranged from $1.00 for poorer grades intended for road base to about $3.00 for rock of 96 to 98% $CaCO_3$. --M. H. Rice.

1-1807. California, Div. Mines, CALIFORNIA MINING REVIEW, 1958: Its: Mineral Inf. Service, v. 12, no. 1, p. 1-7, illus., map., Jan. 1959.

The total value of mineral production in California declined for the first time in 7 years. The drop, about 12%, lowered the total production to $1,451,000,000. All fuels dropped in the value of their total production, as did the other 2 major groups of commodities, metals and nonmetals. A few particular commodities showed a rise in production, among them Au, Hg, Mn, Mo, and rare earths among the metals, and barite, cement, diatomite, and gypsum of the nonmetallic commodities. --M. H. Rice.

1-1808. Hall, Wayne E., and E. M. MacKevett, Jr. ECONOMIC GEOLOGY OF THE DARWIN QUADRANGLE, INYO COUNTY, CALIFORNIA: California, Div. Mines, Spec. Rept. 51, 73 p., illus., 9 pls. incl. geol. map scale 1:125,000 (in pocket), Oct. 1958, 37 refs.

The Darwin quadrangle is in W.-central Inyo County. Through 1951 it has yielded an output of about $37,500,000 worth of Pb, Ag, Zn, steatite-talc, and W. This report contains a brief descriptions of the mineral deposits.

Paleozoic rocks consist mostly of an essentially conformable sequence, about 14,000 ft. thick, of dolomite and limestone ranging in age from Early Ordovician to Permian. These strata are intruded by Mesozoic intrusive rocks of the Coso and Hunter Mountain batholiths. Cenozoic volcanic flows overlie most of the northern half of the quadrangle.

The Paleozoic strata strike from N. to N. 30° W. and dip gently westward. Near major intrusive bodies the structure is much more complex.

The mineral deposits are peripheral to the Coso Range batholith. On the E. side of the batholith are the Pb-Ag-Zn mines of the Darwin district, which lie mainly on the western side of the Darwin Hills. W deposits are on the eastern side of the hills. Talc deposits are in the Talc City Hills at the northern end of the batholith.

Limestone altered to calc-hornfels is the host rock for most of the Pb-Ag-Zn deposits, and the W deposits are in tactite; dolomite and quartzite are the host rocks for the talc deposits. Fractures have controlled deposition of most ore bodies. --P. K. Morton.

1-1809. Stroudth, Howard S. SOUTH AFRICAN MINING-A TIME TO INVEST?: Mining Engineering, v. 11, no. 5, p. 502-505, 5 illus., May 1959.

Personal opinions and firsthand information on politics, economic atmosphere, and mining opportunities in the Union of South Africa. Specifics are included on labor, transportation and harbor facilities, availability of properties. Added are brief commentaries on ferrous ores, Cr, U, and Au, coal and energy, pegmatites in general, Cu, and other minerals. --Auth.

See also: Geologic Maps 1-1603; Areal and Regional Geology 1-1619; Structural Geology 1-1639; Stratigraphy 1-1646, 1-1664 through 1-1669; Geophysics 1-1707, 1-1724, 1-1726 through 1-1732; Geochemistry 1-1744.

1-1810. Hardin, George C., Jr. ECONOMIC FACTORS IN THE GEOLOGICAL APPRAISAL OF WILDCAT PROSPECTS: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 14-19, 7 figs., 1958, 2 refs.

Appraisal of exploratory or wildcat prospects is primarily the duty of petroleum geologists. Geological factors such as amount and quality of structural control and the type and quality of reservoir rocks expected must be evaluated. However, in arriving at a decision as to whether or not a prospect is to be drilled, this evaluation of geological factors must be controlled by economic factors such as amount of possible productive acreage available, cost and type of leases, cost of the exploratory well, and other purely economic considerations. Many geologists successfully base such appraisals on their experience without having a definite formula as a guide. A rather loose formula or "rule of thumb" based on exploratory drilling statistics in the area of operations can be used as a guide in making decisions as to the drilling of exploratory prospects. It is suggested that in the Gulf Coast, the minimum net return to be expected from the oil and gas to be ultimately produced from a new field found by an exploratory well, if the field should be comparable to other fields in the same trend with similar structural conditions, should exceed 50 times the total amount of money (total cost) risked on the prospect. This relationship is referred to as the profit-to-risk ratio.

The basis for this formula, and the amount of tolerance in its use that is permissible because of geological factors, is discussed, and several examples are analyzed. --Auth.

1-1811. Murr, Edgar W. SALT CAVERNS FOR PETROLEUM PRODUCTS: Military Engineer, v. 51, no. 340, p. 128-30, 3 illus., March-Apr. 1959.

Several types of storage facilities for aviation petroleum products have been considered in efforts to reduce storage costs; they include the Edholm container which depends on hydrostatic pressure to contain the product, rock quarries, stabilized-soil storage, and salt domes and caverns. In areas where salt beds occur, the creation of artificial caverns offers good promise for successful storage facilities. In the wet-cavern method it is necessary to maintain a reservoir of brine to displace the petroleum as it is removed. In the still unsuccessful, but potentially more efficient dry-cavern method, the created cavern is supposed to maintain its shape and storage capabilities even when completely empty of all liquid. --M. Russell.

1-1812. Baker, Bruce L., and Gordon W. Hodgson. MAGNESIUM IN CRUDE OILS OF WESTERN CANADA: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 2, p. 472-76, graph, 4 tables, Feb. 1959, 11 refs.

Crude oils of Cretaceous, Jurassic, Mississippian, and Devonian age of western Canada were analyzed for Mg, V, and Ni. The method of analysis is given. The Mg content relative to Ni fell in the range of 60% to 1%. The Mg content relative to V ranged from 70% to 1%. A chart shows the content of Mg, V, and Ni in crude oils plotted as a function of time. --M. Russell.

1-1813. U. S. Bureau of Mines and U. S. Geological Survey. PETROLEUM EXPLORATION AND RESEARCH IN THE UNITED STATES AND A REVIEW OF WORLD SUPPLY, 1957. Contributions to ECAFE. Symposium on Development of the Petroleum Resources of Asia and the Far East: variously paged, maps, diags., graphs, tables, [Washington, D.C., 1958?], refs.

The papers presented in this volume are listed below. Titles indicated in CAPITAL LETTERS are separately abstracted.

1) Morrison, Warren E. WORLD PETROLEUM REVIEW, 1957, 20 p.

2) Petroleum Exploration in the United States, 47 p.
Fischer, William A. PHOTOGEOLOGY, p. 3-8.
Pakiser, Louis C. GEOPHYSICAL EXPLORATION, p. 9-18.
Wilhelm, Clarence J. EXPLORATORY DRILLING, p. 19-21.
Roberts, Albert E., John C. Maher, and Carl M. Bunker. SUBSURFACE STRATIGRAPHIC TOOLS AND TECHNIQUES, p. 23-44.
Gryc, George. PETROLEUM EXPLORATION IN ALASKA, p. 45-47.

3) Kintz, G. M. Safety in Seismic Petroleum Exploration, 12 p.

4) Taliaferro, D. B. CONSERVATION OF PETROLEUM RESERVOIR ENERGY, 26 p.

5) Lankford, J. Daniel, and Grace M. Nolan. PETROLEUM RESEARCH IN THE UNITED STATES, 18 p.

1-1814. Morrison, Warren E. WORLD PETROLEUM REVIEW, 1957: (In: U. S. Bureau of Mines and U. S. Geological Survey. Petroleum Exploration and Research in the United States and a Review of World Supply, 1957: 20 p., 10 figs. incl. maps, graphs, tables, [Washington, D.C., 1958?]) refs.

In 1957 petroleum and natural gas contributed 34 and 11% to the world production of primary energy - estimated for the year at 3,982 million metric tons of coal equivalent. The respective contributions of coal and hydroelectric power were 47 and 8%. Over the past 20 years petroleum and natural gas have been largely responsible for doubling of world energy production. During this period the petroleum output expanded 3 1/2 times and natural gas output 4 times, but the production of coal increased only about one-third.

Worldwide production of petroleum, mainly crude oil, reached 6,745 millions of barrels in 1957. Activity during the year was characterized by severe fluctuations in output in major producing countries. In the first quarter the Middle East crisis was at its peak, with output in that region affected by the closing of the Suez Canal and the shutdown of pipelines from Iraq to the Mediterranean seaboard. To meet the ensuing shortfall in Middle East deliveries to Western Europe, output was increased in the Western Hemisphere, mainly by the United States and Venezuela. However, by midyear the crisis was over, and with reopening of the canal and pipelines, Middle East production gradually returned to normal. There followed a downward adjustment in output in the Western Hemisphere during the second half of the year, but not soon enough to avoid excess supplies, particularly in the United States. Cutbacks in the Western Hemisphere canceled out much of the ex-

pansion of the first 6 months, so that world output for 1957 was only about 5% above 1956.

In contrast to petroleum, natural gas output continued its steady upward trend in 1957. World marketed production for the year is tentatively estimated at 11,600 thousand million cu. ft., or about 9% greater than in 1955. About 92% of this was in the United States. In addition to commercial production, vast quantities of gas were flared in the Middle East, South America, and Caribbean regions because of the lack of local markets or facilities to transport this to consuming areas.

Although no complete data are available on world demand for major refined products in 1957, this is tentatively estimated to have been about 4% higher than the 5,389 million barrels consumed in 1956. The small gain during the year is attributed to the effects of the Middle East crisis on Western Europe supply, as well as a leveling of demand in that area and in the United States. Demand in 1957 remained concentrated within the heavily industrialized parts of North America and Europe (including the U. S. S. R.), which together represented about 86% of the world total. The remaining 14% was in relatively less industralized regions - namely, South America and the Caribbean, Middle East, Africa, and South Asia, Far East, and Oceania. In contrast, about 40% of the world crude supply came from these regions.

The world output of refined products in 1957 averaged about 16,300 thousand barrels daily - an increase of about 4% over 1956. Half of this was refined in North and Central America, mainly the United States, one-fourth in Western and Eastern Europe, and the remaining fourth in other localities. World refinery capacity during the year reached 19,460 thousand barrels of crude distillation daily. This was distributed areawise about the same as the output of refined products. The ratio of output to refinery capacity was only 84%, reflecting considerable excess capacity in Western Europe and the United States.

The normal pattern of world oil movements was disrupted during the last 2 months of 1956 and the early part of 1957 by the Middle East crisis. To compensate for the shutdown of the Suez Canal and pipelines from Iran to the Mediterranean seaboard, the direction and flow of oil trade were altered during this period. This included routing tankers around the Cape of Good Hope and additional shipments to Western Europe from the Western Hemisphere. Another aspect of the crisis was the expansion of tanker tonnage, which in 1957 rose to a record 49,582,000 deadweight tons and 3,035 units. However, with the return of oil movements to normal during the second half of the year, tanker tonnage was in increasing surplus.

In the United States drilling activity declined in 1957, and the number of exploration and development wells completed fell to 53,838, or 7% below the previous year. However, in the rest of the world (outside of Eastern Europe, for which no data are available) the search for new reserves of oil and gas was intensified. There the number of wells completed increased to 5,006, or 13% more than in 1956. Most of the expansion occurred in North America (Canada), South America and Caribbean, the Middle East, and Western Europe.

World proved reserves of crude petroleum were estimated at 263,134 million barrels in 1957. About two-thirds of this was concentrated in the Middle East, where there is only about 1% of world oil demand. In contrast, North and Central America, with over half of world demand, had only 15% of reserves. Elsewhere in 1957, South America and the Caribbean had 7% of the reserves; the South Asia, Far East, and Oceania region 3%; and other regions including Africa and Western Europe less than 1%. In Eastern Europe, including the U. S. S. R., proved reserves were estimated at about 10% of the world total. No data are available on world reserves of natural gas. However, these are mainly concentrated within the major petroleum producing areas of the world.

Petroleum and natural gas are expected to meet most of the anticipated increase in world energy requirements over the next decade. With coal production increasing at a relatively slower rate, oil and gas may soon displace coal as the world's ranking energy resources - a situation that already exists in the United States, where these fuels together produced 64% of its primary energy in 1957. The present deceleration of expansion of petroleum demand in some areas is considered only a short-run phenomenon caused by the economic readjustment now underway in the United States and to a smaller extent in Western Europe. This, however, is not expected to affect the long-run demand for energy. It has been estimated that over the next decade the world demand for petroleum alone, outside the Eastern Europe, will increase at the rate of about 6.2% annually. In Eastern Europe, including the U. S. S. R., demand is tentatively expected to increase at about the rate of 9% annually during the period. With the present large world reserve-production ratio for crude oil, estimated in 1957 at 39:1, supply over the next decade will easily meet anticipated world demand - provided, of course, that there is no interruption to the free flow of petroleum and products thereof between surplus and deficit production regions of the world. --Auth.

1-1815. Fischer, William A. PHOTOGEOLOGY: (In: U. S. Bureau of Mines and U. S. Geological Survey, Petroleum Exploration and Research in the United States and a Review of World Supply, 1957. 2. Petroleum Exploration in the United States, p. 3-8, [Washington, D. C., 1958?]).

Photogeologic procedures have been used by many private companies and by the U. S. Geological Survey in mapping many geologic terranes in the United States and Alaska. Thus far more than 200,000 sq. mi. have been mapped by the U. S. Geological Survey at scales ranging from 1:4,000 to 1:250,000. The greater part of this work has been in connection with the exploration of U. S. Naval Petroleum Reserve No. 4 in northern Alaska, and the Colorado Plateau of the western United States. General geologic reconnaissance maps, isopachous maps, structure contour maps, and detailed maps of structural elements in mineralized areas have been prepared. Precision stereoplotting instruments, such as the Kelsh plotter, and simple stereometer instruments, were used.

Studies of the application of color photography to geologic mapping have shown that many geologic features can be recognized with more certainty and traced more continuously on color aerial photographs than on conventional black-and-white photographs. New photogrammetric instruments are being developed for geologic use, and research is being conducted on methods of obtaining more information from aerial photographs. The use of photogeologic techniques is increasing the rate of geologic mapping and affords a better understanding of stratigraphic and structural settings. --Auth.

1-1816. Pakiser, Louis C. GEOPHYSICAL EXPLORATION: (In: U. S. Bureau of Mines and U. S. Geological Survey. Petroleum Exploration and Research in the United States and a Review of World Supply, 1957. 2. Petroleum Exploration in the United States, p. 9-18, [Washington, D. C., 1958?]).

Since World War II use of the seismograph in geophysical exploration for petroleum has increased, and use of the gravity meter and magnetometer has decreased. During this period the success ratio of exploratory wells drilled on the basis of geophysics, or geology and geophysics combined, has declined because oil and gas are increasingly difficult to find. Gravity and magnetic methods tend to be used for reconnaissance surveys, and the seismic method for detailed surveys, but there are exceptions. In the Far East the gravity and magnetic methods will probably be of relatively more importance.

Recent improvements in the seismic reflection method have included the use of many more geophones, pattern shooting, tape recording, data processing systems, continuous velocity logging in drill holes, and falling-weight pulses. The gravity meter has been made lighter and more compact. The airborne magnetometer, of recent development, is especially useful in regional studies, especially in areas difficult to reach by land transportation.

Research is an important aspect of geophysics. Much of it deals with theoretical problems having no immediate economic objectives. --Auth.

1-1817. Wilhelm, Clarence J. EXPLORATORY DRILLING: (In: U. S. Bureau of Mines and U. S. Geological Survey. Petroleum Exploration and Research in the United States and a Review of World Supply, 1957. 2. Petroleum Exploration in the United States, p. 19-21, [Washington, D.C., 1958?]).

About one of every 4 wells drilled in the United States is classified as an exploratory well. Fewer potential oil-productive zones are overlooked as a result of new techniques and equipment now in use. However, petroleum and natural gas are becoming increasingly difficult to find, as exemplified by the increased average depth of wells drilled, which reached 4,113 ft. in 1957. --Auth.

1-1818. Roberts, Albert E., John C. Maher, and Carl M. Bunker. SUBSURFACE STRATIGRAPHIC TOOLS AND TECHNIQUES: (In: U. S. Bureau of Mines and U. S. Geological Survey. Petroleum Exploration and Research in the United States and a Review of World Supply, 1957. 2. Petroleum Exploration in the United States, p. 23-44, 2 figs., [Washington, D.C., 1958?]) 83 refs.

Some of the more important subsurface stratigraphic tools and techniques used today in the search for oil and gas are electrical, radioactivity, and sample logging, or modifications of these, and micropaleontology.

Electrical logging is the recording of the spontaneous-potential and resistivity of the rock adjacent to the drill hole. Measurements of these properties are commonly made with an electrode or system of electrodes designed to measure the resistivity of rock types at different distances from the drill hole. The spontaneous-potential is the algebraic sum of the natural earth potentials, electrochemical potentials, and electrofiltration potentials. The resistivity is a measurement of the resistance of the rock to the passage of an electric current. This resistance is dependent upon the amount and kind of fluid in the rock and upon the concentration of dissolved salts in the fluid. Different kinds of resistivity curves reveal the apparent or true resistivity and certain physical characteristics of various rocks types. Some of the resistivity logs include the conventional log (short normal, long normal, and lateral curves), laterolog, microlog, microlaterolog, induction log, and variations or combinations of these resistivity logs.

Radioactivity logging reveals properties of subsurface strata adjacent to drill holes by measuring the radioactivity emitted from natural radioisotopes contained in the strata or by measuring radioisotopes either in drill holes or in surrounding strata. Radioactivity logging includes the measurement of: (1) natural radioactivity which is sometimes used to determine rock types and to locate formation contacts; (2) hydrogen content, which is related to porosity, by neutron-neutron or neutron-gamma methods; (3) formation density by the gamma-gamma method; and (4) primary or secondary gamma-ray spectral measurements to determine the presence of particular radioisotopes or elements. Two types of radioactivity logs are sometimes obtained and plotted simultaneously. These are usually the natural gamma-ray and the neutron curves. The neutron curves may be neutron measurements or secondary gamma-ray measurements which represent the relative neutron absorption of the strata.

Sample logging is the visual examination by means of a binocular microscope of rock fragments taken from a drill hole and the recording of the rock types in the order and depths at which they were penetrated. The proportion of representative rock in each sample varies with the care exercised in the collection of samples and with the drilling method used. Two methods are generally used in recording the samples, and the resulting sample logs are classed as percentage logs and interpretive logs.

Micropaleontology aids in the solution of many subsurface geologic problems. The abundance, the wide geographic distribution, and the generally limited stratigraphic distribution of many microfossils make them ideal for use in subsurface stratigraphy. Microfossils obtained from subsurface rock units are used to establish geologic ages of the containing rock units, to establish local and regional correlations, and to indicate environments of deposition. --Auth.

1-1819. Gryc, George. PETROLEUM EXPLORATION IN ALASKA: (In: U. S. Bureau of Mines and U. S. Geological Survey. Petroleum Exploration and Research in the United States and a Review of World Supply, 1957. 2. Petroleum Exploration in the United States, p. 45-47, [Washington, D.C., 1958?]).

Alaska includes several large provinces that are considered to be geologically favorable for the accumulation of petroleum. Between 1902 and 1933 about 154,000 barrels of oil were produced, but at present there is no commercial production. Alaska is now in its third and greatest oil boom. A new field was discovered in 1957 in the previously untested Kenai Peninsula.

The U. S. Navy's petroleum exploration program (1943 to 1953) in northern Alaska was the first in the territory to utilize all the modern petroleum exploration techniques, including aeromagnetic surveys, surface and subsurface geologic studies, photogeologic studies, seismic surveys, and test drilling. --Auth.

1-1820. Taliaferro, D. B. CONSERVATION OF PETROLEUM RESERVOIR ENERGY: (In: U. S. Bureau of Mines and U. S. Geological Survey. Petroleum Exploration and Research in the United States

and a Review of World Supply, 1957: 26 p., 3 figs., [Washington, D.C., 1958?]) 10 refs.

In the early history of the petroleum industry, lack of knowledge and inefficient production practices caused many reservoirs to yield only 15 to 30% of their reservoir oil. Through conservation of natural reservoir energy by engineered field-development programs and efficient production rates and through application of modern stimulative methods, it is estimated that about half of the oil in known reservoirs now is recoverable. In some fields where modern methods of production are being applied, the ultimate recovery of reservoir oil is expected to be as great as 80%. Thus, rewards for using modern conservation practices and engineering techniques are great indeed.

From research and field tests already in progress, it is apparent that new and more efficient methods of oil recovery will be developed. Even now we may be at the dawning of a new day in petroleum production history when - for reservoirs operated under the best principles for using and conserving energy - recoveries of 90% or more of the reservoir oil will be commonplace. --Auth. concl.

1-1821. Lankford, J. Daniel, and Grace M. Nolan. PETROLEUM RESEARCH IN THE UNITED STATES: (In: U. S. Bureau of Mines and U. S. Geological Survey. Petroleum Exploration and Research in the United States and a Review of World Supply, 1957: 18 p., [Washington, D.C., 1958?]).

Petroleum research has increased constantly in the United States, motivated by the growing needs of the oil industry, the manufacturers of petroleum-using equipment, and the consumers; however, the need for information always has been greater than the research effort has been able to supply. Much of the effort has been in applied research, but increasing attention needs to be given to fundamental studies. Thus, while petroleum research is extending the frontiers of knowledge, huge unexplored wildernesses lie beyond.

The cost of petroleum research and development is high. In 1957 the oil industry in the United States probably spent about $280,000,000 in research and development; and employed some 20,000 industry workers at a cost of about $12,000 annually for each research worker, exclusive of investment in facilities. Each year the cost gets higher because of rising overall prices, scarcity of qualified personnel, and greater complexity. Despite the high cost, the investment yields a high return.

An expanded program of research will require greater expenditures and increased efforts by industry, the Government, universities, and commercial research organizations. Especially challenging is the need for discovering new accumulations of oil and gas, and for improving the recovery from known accumulations. Past research has served the industry well, but far more progress is possible.

The benefits of research carried on in the United States have flowed to many other parts of the world, including Asia and the Far East. Such research has made a tremendous contribution to economic development both in the United States and abroad. --Auth.

1-1822. Jardine, D., and B. V. Sanford. DEVELOPMENTS IN EASTERN CANADA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1419-26, 4 maps, secs., 5 tables, June 1959, 4 refs.

In southwestern Ontario during 1958, both exploratory and development drilling decreased slightly from that of 1957. During the year, 99 exploratory wells and 255 development wells were completed. Although there was a marked decline in activity on land, offshore drilling on Lake Erie increased by more than 75% over the previous year. Natural gas production increased by 7% over 1957 to 15,500,000 MCF, and oil production increased 24% to 778,341 bbls. This is the highest since the year 1907, when more than 779,000 bbls. were produced. Six significant discoveries were made in the district during 1958, one each in Kent, Lambton, and Huron counties, and 3 offshore in Lake Erie.

In the remainder of eastern Canada (Quebec and the Maritime Provinces), activity continued at a high level. Eighteen exploratory wells were completed, a decrease from 27 in 1957, but total drilled footage was up slightly over the year. There was a marked shift in locus of exploratory activity from Quebec to the Maritime Provinces, particularly Prince Edward Island, but no oil or gas discoveries were made. --Auth.

1-1823. Bulmer, C. A. S. DEVELOPMENTS IN WESTERN CANADA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1406-1418, 2 maps, 4 tables, June 1959, 14 refs.

The number of exploratory and development wells completed in western Canada during 1958 was 2,436, a decrease of 19% from 1957. Alberta accounted for approximately 60% of the total completions, Saskatchewan 32%, Manitoba 4%, British Columbia 3%, and the Northwest Territories and Yukon less than 1%. Decreases in both exploratory and development drilling were noted in all areas with the exception of Alberta, which recorded a slight increase in the number of development wells. The most promising discoveries were made in Alberta and northeastern British Columbia in sediments of Devonian, Mississippian, and Triassic age.

All production was down slightly due mainly to market proration in Alberta. Gas deliveries to Ontario and Quebec began as the Trans-Canada pipeline completed its last stage.

Geophysical activity dropped considerably below the 1957 level.

Continued interest in the Yukon and Northwest Territories was evident when a major land play developed in the early spring in those areas. --Auth.

1-1824. Blanpied, B. W. EXPLORATORY DRILLING IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1117-38, 3 maps, chart, graph, 13 tables, June 1959.

This report, the 14th based on data gathered by the Committee on Statistics of Exploratory Drilling, is the 23d annual summary on the subject published in the Bulletin. Frederic H. Lahee prepared this statistical analysis and wrote the annual article for 20 consecutive years. Graham B. Moody prepared the report for exploratory drilling for 1956.

During 1958, 13,199 exploratory holes were drilled in the United States and Alaska. Of these, 6,950 were new-field wildcats, 3,191 were new-pool tests (including new-pool wildcats, deeper-pool tests, and shallower-pool tests), and 3,058 were outposts. Among the new-field wildcats, 786 were successful, among the new-pool tests, 809 were successful, and among the outposts 972 were successful.

The total exploratory footage drilled in the United

States and Alaska in 1958 was 61,483,911 ft. in the 13,199 holes, or 4,661 ft. per hole. These figures are comparable with 69,136,266 ft. drilled in 14,707 exploratory holes, with average depth of 4,701 ft. in 1957.

For the 11th time, we are presenting data on Canada and Mexico. --Auth.

1-1825. Richards, Horace G. DEVELOPMENTS IN ATLANTIC COASTAL STATES BETWEEN NEW JERSEY AND SOUTH CAROLINA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1343-44, table, June 1959.

Gas production continued in Garrett County, Maryland, although no new wells were drilled. There was gas production in Buchanan, Dickerson, and Wise counties in Virginia with 15 new wells drilled. There was limited oil production in Lee County, Virginia, although no new wells were drilled. There was no activity in the Coastal Plain between New Jersey and South Carolina. --Auth.

1-1826. St. John, F. B., Jr., and Tracy W. Lusk. DEVELOPMENTS IN SOUTHEASTERN STATES IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1331-42, 2 maps, 13 tables, June 1959, 14 refs.

The southeastern states showed a 10% increase in seismic activity, a 27% decrease in gravity meter, and a 27% decrease in core-drill activity during 1958. Combined activity of these categories, however, was up slightly over 1957. The total number of exploratory tests drilled in 1958 decreased only slightly compared with 1957, although the percentage of successful completions was slightly higher. Production in Alabama increased somewhat due to intensive outpost and subsequent development drilling. Oil production in Mississippi increased slightly as a result of the rapid development of new Upper Cretaceous fields. --Auth.

1-1827. Williams, George Q. DEVELOPMENTS IN NORTH MID-CONTINENT IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1208-1220, map, 7 tables, June 1959.

During 1958 there were 163 new-field and new-pool discoveries in Kansas named by the Kansas Nomenclature Committee of the Kansas Geological Society. The total of 163 discoveries includes 144 oil discoveries, 12 gas discoveries, and 7 for oil and gas. In addition there were 16 discoveries of deeper production in previously producing pools and 40 discoveries of shallower production in previously producing pools. Of the total new discoveries, 21 were in the new-field category, the remainder new-pool discoveries.

Kansas produced 119,942,094 bbls. of oil, 5,361,339 bbls. of natural gasoline and liquified petroleum gas and 535,937,434 MCF of natural gas in 1958.

There were no successful wildcat tests in Iowa or Nebraska (east of the 98th Meridian), and 2 successful new-pool wildcats in Missouri. --Auth.

1-1828. Popenoe, H. L. DEVELOPMENTS IN WEST COAST AREA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1389-1405, 5 maps, graphs, 8 tables, June 1959, 25 refs.

Washington: 6 new-field wildcats were drilled; none were successful. Total exploratory footage was 43,550.

Oregon: 2 unsuccessful new-field wildcats were drilled. Exploratory footage totalled 9,720.

California: 476 exploratory wells with a footage total of 2,453,615 were drilled in 1958. This is a decrease of 18.5% in number of wells and 16.4% in footage below the 1957 totals. Ten new fields, 6 oil and 4 gas, and 29 pools, 25 oil and 4 gas, were discovered. Exploration was 15.3% and 19.7% successful as to wells and footage respectively, compared with 15.6% and 19.3% in 1957. Approximate production in 1958 was 313.7 million bbls. crude oil, down 7.5% from 1957, 28.1 million bbls. natural gas liquids, and 436.8 billion CF natural gas. Basement was reached in 35 unsuccessful exploratory holes. There were 50 active exploratory wells at the end of the year. --Auth.

1-1829. Mann, H. DEVELOPMENTS IN ALASKA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1427-36, 2 maps, table, June 1959, 24 refs.

Exploratory activities in Alaska significantly increased in 1958 as a result of the discovery on the Kenai Peninsula, Cook Inlet area, in 1957. Surface and geophysical mapping increased 500% and 400%, respectively, over 1957, and were conducted by 15 oil companies in 9 areas of interest. These areas, in order of activity, are: Cook Inlet, Nushagak, Bethel, Alaska Peninsula, Porcupine-Kandik, Yukon-Koyukuk, and Arctic Slope.

Drilling increased slightly, with 12 wells active at various times. The total footage decreased however, from 52,480 ft. in 1957 to 47,578 ft. in 1958. In the Kenai district, the Standard-Richfield Swanson River Unit well No. 1, the discovery well completed in 1957, was opened on a sustained production test flowing about 500 B/D from Tertiary nonmarine sands of the Hemlock zone (named by Standard). Swanson River Unit well No. 2, 2 mi. S. of the discovery well, was completed from 2 zones in the "Hemlock" for about 900 B/D. Swanson River Unit well No. 3, located between and about one mile E. of the completed wells, was a dry hole and may limit the easterly extension of the field. A fourth well is now drilling in the unit. In the Ninilchik district, Cook Inlet area, the Standard-Richfield's Deep Creek Unit well No. 1 was abandoned at 14,221 ft. and is Alaska's deepest test to date. No information is available on this well. As of Dec. 31, there were 5 drilling wells in Alaska.

Alaska land filings now total about 40 million acres of which approximately 75% were subsequent to the discovery on the Kenai Peninsula. Four million acres, adjacent to Naval Petroleum Reserve No. 4 in the Arctic Slope area, and originally part of lands withdrawn under Public Land Order 82, were offered in 1958 on a drawing basis following a 60-day "simultaneous" filing period. Sixteen thousand acres on the Gubik gas field were put up for competitive bids. Other parcels of land previously withheld under Public Land Order 82 are to be offered on drawing in the near future.

Impending benefits to the oil industry from Alaskan statehood will be: (1) the availability of tidelands for leasing: (2) the establishment of separate state quotas on lands, excepting those kept in the federal domain for reasons of national defense, etc.

All phases of exploratory activities are expected to increase in 1959. The greatest activity will probably again be in the Cook Inlet area. --Auth.

1-1830. Budd, Harrell. DEVELOPMENTS IN ARIZONA AND WESTERN NEW MEXICO IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1379-88, 2 maps, 5 tables, June 1959.

The year 1958 recorded the first drilling decline in more than 10 years in Arizona and western New Mexico. In all, 877 wells were drilled, a decrease of 11.2% from the 1957 all time high of 988 holes. New-field and new-pool wildcatting resulted in 19 new discoveries and extensions with a success ratio of 18.6%. The success ratio for all types of exploratory wells was 29.3%, higher than average for the area and the nation.

Exploration in the San Juan basin was directed toward stratigraphic traps in the various Cretaceous units, particularly the Gallup and Dakota formations. Exploration in Arizona and W.-central New Mexico was directed toward Paleozoic carbonates, particularly Pennsylvanian sediments.

The most significant developments during the year were the establishment of the Gallup formation as a major oil reservoir in some shallow parts of the San Juan basin, the definition of the Dakota formation as a major gas and condensate reservoir in the deeper parts of the San Juan basin, and the first oil discovery in a new producing zone in northeastern Arizona.

There was a 170% increase in oil production due to completion of the Four Corners pipeline to the west coast. There was a 3% decrease in gas production during 1958. --Auth.

1-1831. Champion, William L., and Sankey L. Blanton. DEVELOPMENTS IN ARKANSAS AND NORTH LOUISIANA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1322-30, map, 8 tables, June 1959, 7 refs.

During 1958, Arkansas drilling activity decreased 24% from the previous year. Louisiana, however, had only 3% decrease in over-all drilling activity.

In all, 527 exploratory tests were completed, 255 in Arkansas and 272 in N. Louisiana.

Exploratory drilling found 17 new fields in Arkansas and 11 in N. Louisiana. Additional 55 successful exploratory wells of other classifications were completed during 1958, 34 in Arkansas and 21 in N. Louisiana.

Geophysical activity in Arkansas decreased only 1% from 1957; N. Louisiana showed a 17% decrease. --Auth.

1-1832. Kinsey, Vail. DEVELOPMENTS IN COLORADO AND WESTERN NEBRASKA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1370-78, map, 4 tables, June 1959, 9 refs.

Total development activity for the 2-state area was down slightly from last year. Exploratory tests totaled 838, a decrease of 156 from last year, while development drilling increased to 735 wells or 49 more than 1957. Eight counties in the Denver basin accounted for 66.5% of all the exploratory tests drilled in the 2 states.

Colorado showed an increase in total drilling of 6.5% over 1957, much of which was due to field development and exploration on the "Western Slope." Nebraska activity decreased nearly 18% due to a sharp reduction in exploratory drilling both in the Denver basin and on the W. flank of the Cambridge arch. Success ratios for exploratory tests increased about 1 1/2% for both states, but again Colorado's "Western Slope" with its ratio of more than 19% was responsible for this gain. There were 34 oil pools and 30 gas pools discovered in Colorado. Most of the gas pools were in the Piceance basin. Nebraska had 45 pools discovered, all of which were oil producers. None of the 1958 discoveries in either state is likely to achieve major field status. The exploratory activity trend in the Denver basin has become well established northward and eastward into Nebraska. Deeper drilling on the "Western Slope" of Colorado was evident, with many tests in the southwestern corner going into the Paradox member of the Hermosa formation. Extreme eastern Colorado's Las Animas arch had very heavy leasing activity following early year successes in the Pennsylvanian of northwestern Kansas. An active lease play also followed the announcement of a 12-well exploratory program in the northern part of the Raton basin. --Auth.

1-1833. Bell, Alfred H., and Jacob Van Den Berg. DEVELOPMENTS IN ILLINOIS IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1183-90, map, graph, 8 tables, June 1959.

In Illinois 2,291 wells were drilled for oil and gas in 1958, as compared with 2,585 in 1957, a decrease of 11%. These figures are exclusive of water- or gas-input wells, salt-water disposal wells, and old wells worked over.

Exploratory drilling decreased 19% from 788 wells in 1957 to 639 in 1958. Eight new pools, 48 extensions, and 14 new pays in producing areas were discovered in 1958. Total oil production increased from 76,649,000 bbls. in 1957 to 80,779,000 in 1958.

Of the 8 new pools discovered in 1958, 3 produced from Pennsylvanian sandstones, 3 from Mississippian sandstones and limestones, and 2 from limestone of Silurian age. --Auth.

1-1834. Carpenter, G. L. DEVELOPMENTS IN INDIANA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1191-96, map, graph, 3 tables, June 1959.

Oil production in Indiana during 1958 totaled 11,811,000 bbls. and was practically unchanged from production during 1957. During 1958, 902 wells were drilled for oil and gas, as compared with 727 wells in 1957, an increase of 24.1%.

Twelve new pools, 16 extensions, and 11 new pays in productive areas were discovered in 1958.

Exploration successes in eastern Gibson County and in Spencer County did much to increase the drilling rate in Indiana during the year. Successes in these 2 areas indicated a concerted exploratory effort toward locating accumulations of oil in stratigraphic traps in Chester sands. --Auth.

1-1835. Nosow, Edmund. OIL AND GAS DEVELOPMENTS IN KENTUCKY IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1173-80, map, 7 tables, June 1959.

The spotlight in Kentucky for the year was held by Green County which broke all recent drilling records for any county in the state, with more than 600 wells completed. This activity helped to push the drilling record for the state over the 2,300 mark, and contributed to the establishment of a new all-time high for annual oil production of 17,956,170 bbls. Gas production decreased slightly to 69,573,461 MCF. Eastern Kentucky had a flurry of activity

when some new development in Breathitt County produced boom conditions in Jackson. Several interesting deep tests in central and eastern Kentucky, including 2 basement tests, added to the knowledge of deeper formations. --Auth.

1-1836. Hyer, Donald E., and Warren Latshaw. DEVELOPMENTS IN LOUISIANA GULF COAST IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1312-21, map, 3 tables, June 1959, 11 refs.

Over-all activity in the Louisiana Gulf Coast during 1958 showed a decline from the previous year. Drilling operations showed a decrease of 13% from 1957. In all, 2,016 tests were drilled, 713 of which were exploratory tests (32.5% successful) and 1,303 of which were development wells (78.2% successful). New-field wildcats numbered 286 (17.4% successful) which resulted in the discovery of 51 new fields. Of the new fields, 15 were oil, 32 gas-condensate, and 4 gas discoveries. The Bonnet Carre field, St. John the Baptist Parish, and the North Fresh Water Bayou field, Vermilion Parish, were the most important onshore discoveries. S. and E. extensions to the Bay Marchand Block 2 field resulted in the most significant additions to offshore reserves, and the southward extensions to the Lake Barre field, Terrebonne Parish, constituted the most significant addition to onshore reserves. The discovery of oil and gas in the Calcasieu Lake field, Cameron Parish, was significant in the fact that prior to 1958 it was the last known piercement salt dome in the onshore Louisiana Gulf Coast to be unproductive. There were 162 new pools and 85 extensions to known fields discovered in 1958. Oil production decreased 4% and gas production increased 15% from that in 1957.

The total of 914 reflection seismograph crew-months represent a decrease of 34% from the previous year. The total of 92 gravity crew-months represents a decline of 21%. There was an increase in the use of subsurface geology and a decrease in the use of the core drill.

Deeper drilling in and adjacent to producing areas constituted a substantial part of the industry's exploratory effort. Strong exploratory efforts were made in the prolific Miocene-Pliocene trend in the southern parishes and adjacent offshore areas and in the deep Oligocene trend of central SW. Louisiana. The average depth of successful new-field wildcats was 11,870 ft. There was no leasing activity in the offshore Louisiana area during 1958. --Auth.

1-1837. Hawkins, Joseph H. THE STRUCTURE AND STRATIGRAPHY OF ERATH FIELD: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 83-91, 7 pls., 1958.

Erath field in Vermilion Parish, Louisiana, is a major producer of oil, distillate, and gas from lower and middle Miocene sands. The structure is an equidimensional dome, with apex shifting northward and flank dips increasing with depth. It is presumed to be a deep-seated salt dome from its proximity and similarity to known salt domes.

Two curved, intersecting normal faults occur, each with its strike in the NE. quadrant and having several hundred feet of throw. The older was active during deposition of the Planulina palmerae zone, as shown by greater thickness of these sediments, especially sand, on the downthrown side. The other, larger fault did not affect deposition of the section penetrated to date.

The fault that was active during deposition controls the occurrence of hydrocarbons in the Planulina zone; the post-depositional fault appears to have had no effect on accumulation. From this it is inferred that the hydrocarbons migrated into the dome before the younger fault developed. --Auth.

1-1838. Price, George W., and Walter A. Wojciechowski. A REVIEW OF WASHINGTON FIELD: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 92-99, 8 figs., 1958.

Washington Field in St. Landry Parish, Louisiana, produces from 6 lower Miocene (Frio) and 2 Eocene Cockfield (Yegua) sands.

All reservoirs are downthrown to a down-to-the-coast normal fault which interrupts the regional coastward (south) dipping homocline. There is slight N. dip into the fault. The limit of Miocene production is controlled by the amount of closure against the fault. The extent of the Cockfield reservoirs results from closure against the fault in combination with facies change. The most extensive reservoir (Cockfield "D") occupies about 9,000 acres and is still undergoing development. Both Cockfield reservoirs are of the volumetric gas-condensate type. Early laboratory tests showed that loss of liquids due to retrograde condensation would be excessive if the reservoirs were simply depleted, so a cycling system has been installed. --G. W. Price.

1-1839. Ives, R. E., and G. D. Ells. DEVELOPMENTS IN MICHIGAN IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1197-1207, map, sec., 4 tables, June 1959, 3 refs.

Michigan again registered a slight decline in drilling activity from the previous years. There were 413 completions as compared with 423 for 1957. Of the 1958 total, 261 were development wells and 152 were exploratory wells. The exploratory wells resulted in 18 discoveries and 134 dry holes. Reworking of older field wells plus the drilling of development wells resulted in 4 additional discoveries.

Total drilled footage for oil and gas tests was 1,156,923 ft., classified as exploratory 414,914 ft. and development 762,611 ft. In 1957, the footage drilled was 1,228,918 ft.

Oil produced during the year totaled 9,308,018 bbls. and gas 10,964,377 MCF. In 1957, 10,168,602 bbls. of oil and 6,639,813 MCF of gas were produced.

Two or 3 gravity crews were working in the state throughout the year. The surveys were conducted in the southwestern and southeastern districts.

A major lease play was active in southern Michigan as a result of the Albion discovery and Scipio field development in Calhoun and Hillsdale counties, respectively. --Auth.

1-1840. Dyer, John R., and Robert H. Burton. DEVELOPMENTS IN MONTANA, NORTH DAKOTA, AND SOUTH DAKOTA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1345-55, map, 7 tables, June 1959.

Exploratory success was up sharply in both Montana and North Dakota. Crude production in both states increased over 1957, but the margin of increase was not as large as the previous year. South Dakota added one new field, and maintained a steady rate of production. --Auth.

1-1841. Kreidler, W. Lynn. GAS AND OIL DEVELOPMENTS IN NEW YORK IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1139-43, map, 3 tables, June 1959.

Twenty-three wells were completed to the Medina gas sand, of which 13 were drilled specifically for gas storage. Oriskany drilling totaled 23 wells. There were 184 oil-field development wells drilled during 1958, and the daily average for pipeline runs amounted to 4,658 bbls. --Auth.

1-1842. Alkire, Robert L., Bernard A. Floto, and Allan W. Johnson. OIL AND GAS DEVELOPMENTS IN OHIO IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1161-68, map, 10 tables, June 1959.

Sixty-two more wells were completed this year than in 1957. Initial gas discoveries were 93,000,000 cu. ft./D greater and oil discoveries were about 2,000 bbls./D less. Increase in gas is due to 75 additional gas-well completions and an increase in volume discovered in combination wells. Oil-well completions (including oil in combination wells) for the past 2 years are comparable in number and average initial production.

The most significant deep test during the year, to explore formations below the Black River in Hinckley Township, Medina County, was being drilled and ultimately reached total depth of 7,040 ft. Production was found from 5,775 to 5,790 ft., and testing is now in process. --Auth.

1-1843. Roberts, M. C. DEVELOPMENTS IN OKLAHOMA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1221-34, 3 figs. incl. map, 15 tables, June 1959.

Exploratory drilling increased 14.4% in Oklahoma during 1958 with 24.3% success; development drilling decreased 2.3% with 67.9% success. Significant new-field discoveries include the East Goodwin of Ellis County, the North Buffalo of Harper County, the Northeast Cheyenne Valley of Major County, the North Dover of Kingfisher County, and the West Enville of Love County.

Close-in outpost drilling, coupled with high-resolution structural and stratigraphic investigations, led to the unusually high exploratory success ratio. This, in turn, has encouraged additional leasing until an all-time high of approximately 60% of the state is under lease.

Seismic activity decreased slightly as compared with previous years. Secondary recovery and production from unallocated "stripper" oil fields continue to account for more than half the oil production in the state. --Auth.

1-1844. Lytle, William S. DEVELOPMENTS IN PENNSYLVANIA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1144-60, 2 maps, 2 secs., 8 tables, June 1959, 27 refs.

The attention of the Pennsylvania oil and gas producers was directed to 5 completions out of numerous significant wells completed in the state during 1958 in deep (Middle Devonian or older) formations. Pennsylvania's first offshore well in Lake Erie on Block No. 1 found 200 MCF of gas per day with a rock pressure of 510 p.s.i. in 24 hrs. after fracturing the Medina section (Lower Silurian). The Joe Kardosh No. 1 in Crawford County became the first basement test in the state. Pennsylvania's first deep commercial oil producer, the Lewis Forro, Jr., No. 1 in Crawford County, was completed for 27 bbls. of oil and 300 MCF of gas per day from the Medina section. The deepest producer in the state, the Royal Rhodes No. 1 in Somerset County, found 3,100 MCF of gas per day after fracturing the Oriskany sandstone (Lower Devonian) at 8,420 ft. The fifth wildcat discovered the Seven Springs field in Westmoreland County. This well, the James S. Blair No. 1, had initial production of 3,663 MCF of gas, natural, from the Onondaga chert (Middle Devonian). During 1958 there were 2 successful new-field wildcats completed, 8 successful new-pool wildcats, including one found by drilling deeper an old well, and 5 successful outpost wells. Of the unsuccessful wildcats, 9 were new-field wildcats and 8 were new-pool wildcats. Four outposts were unsuccessful. The greatest number of deep development wells were drilled in the Rockton field in Clearfield County on the NW. flank of the Chestnut Ridge anticline. This field had 32 development gas-well completions during the year, extending the developed area to a total of about 11,000 acres. One hundred nineteen deep wells were completed in Pennsylvania in 1958, with a total footage of 827,443 ft. Six reactivated wells drilled 330 ft. Of the 119 wells, 75 were gas wells, 2 were oil wells, and 42 were dry holes.

Two new discoveries highlighted the shallow-sand (Upper Devonian or younger) territory of western Pennsylvania. The 2 wells discovered new gas pools in the Balltown and Big Injun sandstones in Westmoreland County. As in 1957 the secondary-recovery projects in the Bradford field and the development drilling in the gas fields dominated the shallow-sand drilling activity during 1958 which decreased from that of 1957. In all, 668 shallow-sand wells were completed. Of these, 258 were gas wells, 24 were oil wells, 46 were dry holes, and 5 were drilled for underground gas storage. Three hundred thirty-five were drilled in connection with secondary-recovery oil operations. In addition to the 668 new wells, 21 wells were deepened aside from the secondary-recovery oil operations, and 17 wells were deepened in connection with secondary-recovery oil operations. The total footage for the new and deepened wells was 1,511,911 ft.

Oil production decreased from 8,210,000 bbls. in 1957 to 6,471,680 bbls. in 1958. Proved oil reserves were estimated at 120,018,000 bbls. as of Dec. 31, 1958. Gas production decreased from 107,004,000 MCF in 1957 to 104,974,000 MCF estimated, in 1958. The total footage drilled, both shallow and deep, was 2,339,684 ft. --Auth.

1-1845. Milhous, H. C. OIL AND GAS DEVELOPMENTS IN TENNESSEE IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1181-82, map, table, June 1959.

A total of 25 test wells were drilled in Tennessee during 1958. One well produced a small amount of oil and 2 noncommercial gas wells were discovered. Exploratory footage for the 25 tests was 20,245 ft. --Auth.

1-1846. Christenson, Maynard G. DEVELOPMENTS IN TEXAS AND OKLAHOMA PANHANDLES IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1235-47, map, 4 tables, June 1959, 5 refs.

Exploratory drilling in the Panhandle district

during 1958 was up 29% from 1957. The over-all exploratory success ratio of 34% reflects another banner year in the Anadarko basin where 41% of the exploratory wells established production.

Development drilling emphasized the increasing importance of the deep gas from the Pennsylvanian reservoirs of the Anadarko basin.

Exploration was active, but generally disappointing, in the Palo Duro and Dalhart basins. --Auth.

1-1847. Bass, J. H. DEVELOPMENTS IN NORTH TEXAS IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1266-75, map, 3 tables, June 1959.

N. Texas continues as an active and major producing area even though total completions and production declined from the previous year. It is significant that the number of exploratory tests decreased 49% from 1957. Emphasis was apparently placed on structural studies of known producing trends and on stratigraphic explorations in the Atoka gas reservoirs of Wise County, where most of the activity occurred. --Auth.

1-1848. Koonce, Gene K., and Frank P. Battan. DEVELOPMENTS IN EAST TEXAS IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1293-1303, map, 7 tables, June 1959, 4 refs.

Drilling activity during 1958 was statistically lower than the preceding year. Discoveries indicate no new major fields but should add substantially to the total reserves of the area.

There were 21 new-field discoveries: 10 in the Upper Cretaceous, 10 in the Lower Cretaceous, and 1 in the Jurassic. Field extension and new-pool discoveries totaled 25.

Total number of wells drilled decreased by 26% from the previous year. The decrease was reflected almost equally in exploratory and development drilling.

Exploratory tests totaled 337, of which 11.3% were successfully completed.

Geophysical activity was restricted to 727 crew-weeks. This is a decline of 20% from 1957 and a continuation of the pattern started in 1953. --Auth.

1-1849. Norris, R. P. DEVELOPMENTS IN WEST-CENTRAL TEXAS IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1276-82, map, 6 tables, June 1959, ref.

Total drilling activity decreased 12.3% in 1958. There were 2,520 wells drilled, as compared with 2,872 wells drilled in 1957. Exploratory wells totaled 964, an increase of 7.0% from the 901 the previous year. Development drilling during 1958 decreased 21.1% to 1,556 wells, as compared with 1,971 in 1957.

Total oil production decreased 10.2% as a result of the lower number of allowable producing days and the decrease in development drilling. In all, 48,928,383 bbls. of oil were produced in 1958, compared with 54,498,934 bbls. the previous year.

Geophysical activity decreased 12% in 1958, as compared with the year 1957. Subsurface geological methods were credited with 76% of the new discoveries. --Auth.

1-1850. Matthews, J. M., H. H. Felsted, and H. W. Deschner. DEVELOPMENTS IN SOUTH TEXAS IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1283-92, map, 5 tables, June 1959.

S. Texas drilling in 1958 was down 14.4% from the 1957 level. Exploratory wells rose 5.4% but development drilling declined 22.4% from the previous year. The 83 discoveries were 10 less than in 1957; one of the new fields is of major importance. Field extensions and new pools added significantly to new reserves. Oil production declined sharply, but gas production increased slightly. Geophysical activity declined 12%, but the decline was least apparent in the Jurassic and Cretaceous trends. The lower Eocene trend showed increased activity. --Auth.

1-1851. Oliver, Fred L. NATURAL GAS IN THE WILCOX TREND OF SOUTH TEXAS: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 77-81, 5 figs., 1958.

The down-dip Wilcox (Eocene) trend in S. Texas, extending from northern Duval County to Lavaca County, includes 193 Wilcox fields, approximately 70% of which produce gas and condensate only.

Wilcox reservoirs average about 20% porosity, 75 md. permeability and 35% connate water, but these properties vary widely from well to well. Water blocking is a major production hazard, and the presence of vertical permeability of the same magnitude as the horizontal leads to coning of water and of gas. Oil production generally is by depletion drive. All these geologic conditions reduce the amount of oil (and gas) that can be recovered, and require well-engineered drilling, evaluation and completion procedures.

Recognition and solution of the problems presented by Wilcox reservoir conditions represents the difference between a sound operation with a good return on invested capital, and a marginal or subeconomic operation. Discovery rate (about 20%) and development costs compared to reserves and income show a good margin of profit. Increasing prices for gas, together with more pipeline outlets, give a firm basis for predicting that activity at a high level will continue for some years in the S. Texas Wilcox trend. --D. C. Van Siclen.

1-1852. Brixey, A. D., Jr., and M. R. Yust. DEVELOPMENTS IN UPPER GULF COAST OF TEXAS IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1304-1311, map, 5 tables, June 1959, 10 refs.

This report covers the drilling activity in the upper Gulf Coast of Texas. Located in the southeastern corner of Texas, the area includes 29 counties, comprising Texas Railroad Commission District No. 3, as well as the adjacent Continental shelf.

There was a further decline in both drilling and oil production in 1958. The Texas statewide number of producing days in 1958 averaged 10.16 days per month versus an average of 14.25 producing days per month in 1957. Gas production, however, increased slightly over 1957.

In 1958, 32 new oil and gas fields were discovered, most of the discoveries being along the deep Frio, Yegua, and Wilcox (Eocene) formational trends.

Onshore exploration and drilling activity declined during 1958. On the Continental shelf, 3 more wildcats were drilled in 1958 than in 1957, resulting in the discovery of one new field. It is hoped that

both exploration and drilling will show an increase during 1959. --Auth.

1-1853. Hanson, Bernold, M., et al. DEVELOPMENTS IN WEST TEXAS AND SOUTHEASTERN NEW MEXICO IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1248-65, 2 maps, 2 graphs, 5 tables, June 1959, 30 refs.

The 1958 recession curtailed operations in W. Texas and SE. New Mexico to the extent that both exploratory tests and total wells drilled were 13% below the 1957 high. This is the first decline in exploratory tests since 1954. 6,280 wells of all classes were drilled in the area. With reduced allowables, production for the year was 438,705,749 bbls., or 20% below the 1957 record year. Success ratio for all exploratory wells was 27%; the ratio for development wells was 90%. The most important discoveries were the Brown-Bassett field of Terrell County, Texas; the Dunigan, Happy, Red Loflin, and Teas fields in northern Borden and southwestern Garza counties, Texas; the Good SE. field in southern Borden County, Texas; the Block 9 field in Andrews County, Texas; the I. A. B. (5070 Penn) field in Coke County, Texas; the Little Lucky Lake field in southern Chaves County, New Mexico; and the South Vacuum field, Lea County, New Mexico.

Exploratory methods followed the same pattern as in previous years. Subsurface methods accounted for 38 discoveries, seismic 14; seismic and subsurface methods combined accounted for 15 successful wells, and 7 were drilled by nontechnical or unknown methods. From the statistics it appears that more emphasis is being placed on detailed subsurface geological studies. Geophysical activity was 25% below the 1957 level. The Delaware basin continued to be the most active area from the standpoint of seismic work.

The concentration of interest in the Val Verde basin, NE. part of the Midland basin, northwestern shelf, and parts of the eastern shelf, accounted for a majority of lease acquisitions in the area. The state conducted only one University Land Sale but the bonus prices remained high. It is anticipated that more joint ventures and drilling units will result, in view of the unavailability of land in favorable areas. Acreage is being dropped in areas considered least promising. --Auth.

1-1854. Preston, D. A., and Graham S. Campbell. OIL AND GAS DEVELOPMENTS IN UTAH AND NEVADA IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1364-69, 2 maps, 6 tables, June 1959.

Exploratory drilling in Utah decreased slightly during 1958. Wells drilled were off 17%, and footage drilled off 14%. The success ratio fell sharply from 21. 3% to 10. 1% due largely to a poor new-field wildcat record for the Four Corners area. Geophysical activity was off 45%. Development drilling increased by 53% and maintained an 85. 2% success record. The Four Corners and Texas-New Mexico pipelines were completed, an event which was reflected by a 463. 5% jump in production. Leasing fell off more than 200%, caused principally by lack of available lands in the areas of greatest interest.

Activity in Nevada came practically to a standstill. Only one well was completed during the year and no geophysical work was reported.

The outlook for 1959 indicates heavier drilling in the Uinta basin and the Kaiparowits and Circle Cliffs areas. Activity in the northern and western part of the Paradox basin should continue at about the same level. --Auth.

1-1855. Eaton, Eugene C. DEVELOPMENTS IN WYOMING AND IDAHO IN 1958: Am. Assoc. Petroleum Geologists, Bull., v. 43, no. 6, p. 1356-63, map, 4 tables, June 1959, 3 refs.

Nine new oil fields and 8 new gas fields were discovered in Wyoming as a result of 195 new-field wildcats. Thirty-nine discoveries were made from the 284 total exploratory wells drilled. Major discoveries were oil in the Dakota and Minnelusa formations for new fields in the Powder River basin, oil from the Tertiary in the Wind River basin, and continued gas discoveries in the Big Piney-LaBarge area, and the Desert Springs and Wamsutter areas in the Green River basin.

The bulk of exploratory drilling for 1959 will probably be concentrated on (1) the eastern side of the Powder River basin drilling for Dakota and Minnelusa oil, and (2) in the Green River basin on the western flank and the E. -central part drilling for gas.

The only well drilled in Idaho in 1958 was abandoned at 2, 835 ft. --Auth.

1-1856. Wier, Charles E. COAL STRATIGRAPHY AND RESOURCES STUDIES, 1949-1957: Econ. Geology, v. 54, no. 4, p. 629-65, fig., 2 tables, June-July 1959, 303 refs.

More than 300 papers dealing with stratigraphy and resources studies on coal-bearing rocks in the United States and Canada have been published during the past 9 years. Most of these have been published by the U. S. Geological Survey, the U. S. Bureau of Mines, and the state surveys for Illinois, Indiana, Kansas, Kentucky, Missouri, Ohio, Pennsylvania, and West Virginia.

The U. S. Geological Survey has published more than 40 Coal Investigations Maps, which cover 7 1/2-minute quadrangles, 15-minute quadrangles, coal fields, or coal districts. Circulars have been published which include the calculation of coal reserves for Colorado, Indiana, Michigan, Montana, New Mexico, Oklahoma, Oregon, North Dakota, South Dakota, Virginia, and Wyoming. The U. S. Bureau of Mines has completed more than 40 county reports which estimate the known recoverable reserves of coking coal in Kentucky, Maryland, Pennsylvania, Tennessee, and West Virginia. --Auth.

1-1857. Clegg, Kenneth E. SUBSURFACE GEOLOGY AND COAL RESOURCES OF THE PENNSYLVANIAN SYSTEM IN DOUGLAS, COLES, AND CUMBERLAND COUNTIES, ILLINOIS: Illinois State Geol. Survey, Circ. 271, 16 p., 3 figs. 3 pls. incl. maps, cross sec., 1959, 13 refs.

Pennsylvanian strata of E. -central Illinois were studied to determine the geologic structure and coal resources of Douglas, Coles, and Cumberland counties.

The general character of the Pennsylvanian strata is reported, with emphasis on the interval that includes the commercially important coal beds (lower McLeansboro and Carbondale groups). The more useful "key beds" are discussed in both regional and local aspect, and tops of 3 of them, No. 7, No. 6, and No. 2 Coals, were used as datum surfaces for structure contour maps.

The major structural feature of the 3 counties is the La Salle anticlinal belt, which separates the Bellair-Champaign uplift on the E. from the deep part of the Illinois basin on the W. Each of these 2 areal segments is characterized by smaller structures.

Coal production of the area has been limited in the past, and an evaluation of coal reserves based on available information does not indicate that coal in the 3 counties is ever likely to attain the economic importance it has achieved in other parts of Illinois. More data on thickness of coal are needed, however, for an accurate evaluation of coal reserves. --Auth.

1-1858. Guennel, G. K., and Richard C. Neavel. PAPER COAL IN INDIANA: Science, v. 129, no. 3364, p. 1671-72, 6 illus. on fig., June 19, 1959, 8 refs.

The foliated, papery texture of the upper third of an 18-in. coal seam in a strip mine near Rockville, Indiana, is attributable to matted plant cuticle. The cuticles of pinnules, pinnae, and rachides resemble Sphenopteris bradfordii Arnold and thus differ from the lycopsid stem cuticles of the Russian paper coal. --Auth.

1-1859. Koppe, Edwin F. AREAL DISTRIBUTION OF PARTINGS IN THE UPPER FREEPORT COAL, FREEPORT QUADRANGLE, PENNSYLVANIA: Pennsylvania Acad. Sci., Proc., v. 32, p. 128-32, 4 figs., 1958, 2 refs.

Thin partings in coal seams often have considerable areal extent. The occurrence of such partings were plotted for the Upper Freeport coal [Pennsylvanian]. The number of partings detected are useful in suggesting the topography upon which the coal was deposited. Some present-day structures coincide with the inferred paleo-topographic features. --Auth.

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See also: Geophysics 1-1718, 1-1719.

1-1860. Hughes, R. J., Jr. VOLUME ESTIMATES FROM CONTOURS: Econ. Geology, v. 54, no. 4, p. 730-37, 2 figs., June-July 1959, 8 refs.

Volume estimates by use of contours find their application in many fields. A practical method of computing volumes by use of contours which the author believes of value to geologists is presented here. It is not original, and is one of many such mathematical approaches, but it has a simplicity particularly suited for stratigraphic and economic estimates of masses. It has not appeared in geological journals, and the writer believes that geologists will find it useful in many situations. An example of this method of estimating volumes from contours is given, in terms of ascertaining the "cut" and "fill" necessary to grade a given area, 500 ft. by 700 ft., for a 1% slope, N. to S. A contour interval of 1 ft. is used, and the map scale is 1 in. to 100 ft. --Auth.

1-1861. Duvall, Wilbur I., and Thomas C. Atchison. ROCK BREAKAGE WITH CONFINED CONCENTRATED CHARGES: Mining Engineering, v. 11, no. 6, p. 605-611, 15 figs. incl. illus., graphs, 4 tables, June 1959, 17 refs.

This paper describes instrumented blasting tests and presents experimental data on crater formation in 4 rock types using small charges in a drillhole which break to one free surface. The compressive strain pulses generated in the rock at the time of detonation of the charges have been recorded and measured. High-speed movies of crater tests have been taken which show the various phenomena that take place during the process of crater formation. From analysis of these data the primary cause of rock breakage in a crater test is shown to be the result of tensile stresses developed when the compressive stress pulse reflects from the free surface. --Auth.

1-1862. Lea, Norman D. THE DEAS ISLAND TUNNEL: Military Engineer, v. 51, no. 342, p. 289-92, 4 illus., map, cross sec., July-Aug. 1959.

The Deas Island Tunnel is being built by the trench method under the Fraser River at Vancouver, British Columbia. A tunnel was chosen rather than a bridge partly because the deep loose soil is more suited to a tunnel. The tunnel proper consists of 6 concrete sections each weighing 18,000 tons which were floated to position, sunk into positions stabilized with riprap, connected, and the space under the tunnel filled by jetted sand. The tunnel is designed to withstand earthquake shear waves equivalent to 21% of gravity, the maximum the soil is estimated to be able to transmit. --M. Russell.

1-1863. Henderson, Donald H. REFRIGERATED FOUNDATIONS IN PERMAFROST: Military Engineer, v. 51, no. 340, p. 118-19, 3 illus., 2 figs., March-Apr. 1959.

It was necessary in constructing Nike sites at the Thule, Greenland, air base, to place foundations so deep within the permafrost layer that the usual gravel-fill, ventilated type would have entailed great quantities of excavation. Instead, the necessary thermal balance is achieved through a lowering of foundation temperatures in summer by a fully automatic, thermostatically controlled, continuous circulating, refrigerating system built within the foundation. --M. Russell.

1-1864. Anderson, Donald L. SHAFT SINKING AND DEVELOPMENT UNDER HOT WATER CONDITIONS: Mining Engineering, v. 11, no. 6, p. 592-93, 5 figs., June 1959.

Presence of hot water brought on by volcanic action nearby has severely complicated mining in the Limon Au mine in Nicaragua. Routine pumping problems have been multiplied and ventilation is a major problem. Enclosing rock is so hot that 20% of all power generated at the mine is consumed by forced ventilation. But hot water underground, however disagreeable and troublesome, may be handled and surmounted like any other difficulty if the estimated profit margin permits. --Auth.

1-1865. Barry, G. S., comp. BIBLIOGRAPHY OF GEOLOGY OF THE PRECAMBRIAN AREA OF MANITOBA, 1950-1957: Manitoba, Dept. Mines & Nat. Resources, Mines Branch, Pub. 57-3, 39 p., 1959.

This bibliography is intended to serve as a supplement to Publication 51-1 which contained references on Manitoba's Precambrian up to 1950. The present list covers the period 1950 to 1957.

The bibliography is divided into 4 parts. Pt. I contains references indexed according to the names of authors, listed in alphabetical order. The full titles and references are given in this section. In Pt. II references are indexed according to subject, and only the author's name and date of publication are given for each subject reference. The full reference may be obtained by referring back to Pt. I. Pt. III lists references according to geographical location, followed by general topics; as in Pt. II, only the author's name and date is recorded.

Lists of geophysical and geological maps, published from 1951 to 1957 by the Manitoba Mines Branch and the Geological Survey of Canada, are contained in Pt. IV.

A number of publications and reports written prior to 1950 but omitted from the earlier bibliography, [Publication] 51-1, have been included in the present bibliography. These have been placed in the appropriate places in Pts. I, II, and III, and are listed separately in the Appendix. --Auth. pref.

1-1866. Whitcomb, Lawrence. GREAT BRITAIN, MOTHER OF GEOLOGY: Pennsylvania Acad. Sci., Proc., v. 32, p. 146-50, 1958.

Conditions existing in Great Britain at the beginning of the 19th century had profound effect on the development of geology. The completeness of the sedimentary record, the large areas uncomplicated by major structures, the variety of geologic problems were advantageous. In addition, there was a favorable geographic and cultural environment. --Auth.

1-1867. Pennsylvania Geological Survey. GEOLOGICAL RESEARCH IN PENNSYLVANIA, 1959: Its: News Letter no. 4, 8 p., June 1959.

A compilation of projects underway in Pennsylvania in the following fields: general geology, including areal mapping; geomorphology and Pleistocene geology; geophysics; ground water; economic geology; mineralogy and geochemistry; paleontology; petrography and sedimentary petrology; sedimentation; stratigraphy; structural geology. Under each subject, projects are listed alphabetically by the name of the principal research worker, and a very brief description of each project is given. --A. C. Sangree.

1-1868. Crawford, Arthur L. UTAH LIBRARY OF SAMPLES FOR GEOLOGIC RESEARCH: State Geologists Jour., v. 11, no. 1, p. 72-76, Apr. 1959.

The earliest libraries were of clay tablets in the ancient cities of the Near East. In a very real sense, the earth's shell is nature's library for those who are trained to interpret the record. To facilitate the assembly, classification, and preservation of the data available from stratigraphic sections, drill cores, oil well cuttings, and various electric, radiographic, and other logs the Utah Geological and Mineralogical Survey in cooperation with the Department of Geology and the Research Committee, University of Utah, has now established a Library of Samples for Geologic Research.

Already samples from 700 oil wells, representing 4,000,000 ft. of drilling are neatly packaged, catalogued and conveniently stored for research and study. Many other types of samples and records are also on file.

Until some more satisfactory method can be found for financing the service, patrons will be charged for use of the library facilities. A schedule of prices and hours can be obtained from the Survey. --Auth.

1-1869. Ellison, Samuel P., Jr. EMPLOYMENT OUTLOOK FOR NEW GEOLOGY GRADUATES: Gulf Coast Assoc. Geol. Soc., Trans., v. 8, p. 7-11, 7 figs., 1958, 10 refs.

Extrapolation of curves of mineral production, oil and gas production, population and numbers of geologists in training in schools indicate that the number of geologists will increase in the future. The demand for earth materials will increase with the growth of population. The supply of earth products will rise and fall in accordance with the production laws of exhaustible resources. The supplies of new geologists will be affected by both the demand for earth materials and the supply of earth materials. The number of geology majors in United States colleges and universities is predicted to rise from the present estimated 6,000 to an estimated 9,000 by the year 2000. The geology enrollment at the University of Texas is predicted to double the present amount by the year 2000. The level of training for geologists will rise so that the Ph. D degree will be the optimum desired and the Masters degree will be the absolute minimum. --Auth.

AUTHOR INDEX